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The Latest United States Battleship

Description of the Battleship Texas, Built by the Newport News Shipbuilding and Dry Dock Co.—Machinery Details and Trial Data

With the completion and acceptance of the U. S. S. *Texas* the United States Navy adds to its now strong and formidable list of battleships one of the staunchest and most successful ships among those recently built for the naval establishment.

The *Texas* and *New York* were authorized by act of Congress approved June 24, 1910, an appropriation of $6,000,000 (£1,230,000) for the construction of each of these vessels being provided; the above sum being exclusive of armor and armament, together with various fittings usually supplied by the Government.

The contract for the construction of the *Texas* was awarded the Newport News Shipbuilding and Dry Dock Company, of Newport News, Va., at their bid of $5,830,000 (£1,195,000), the time of completion, according to contract, being 36 months, or December 17, 1913. The keel was laid April 17, 1911, the ship was launched May 18, 1912, and the full power trial consummated October 28, 1913.

The *New York,* now building at the New York Navy Yard, is also rapidly nearing completion. The two ships are, with the exception of minor details, practically the same as regards hull and machinery.

The principal hull dimensions of the *Texas* are:

Length over all	573 feet 0 inches
Beam, on load waterline	95 feet 2½ inches
Mean draft	28 feet 6 inches
Block coefficient	0.61
Full load displacement, tons	28,367
Trial displacement, tons	26,250
Capacity of coal bunkers, tons	2,892

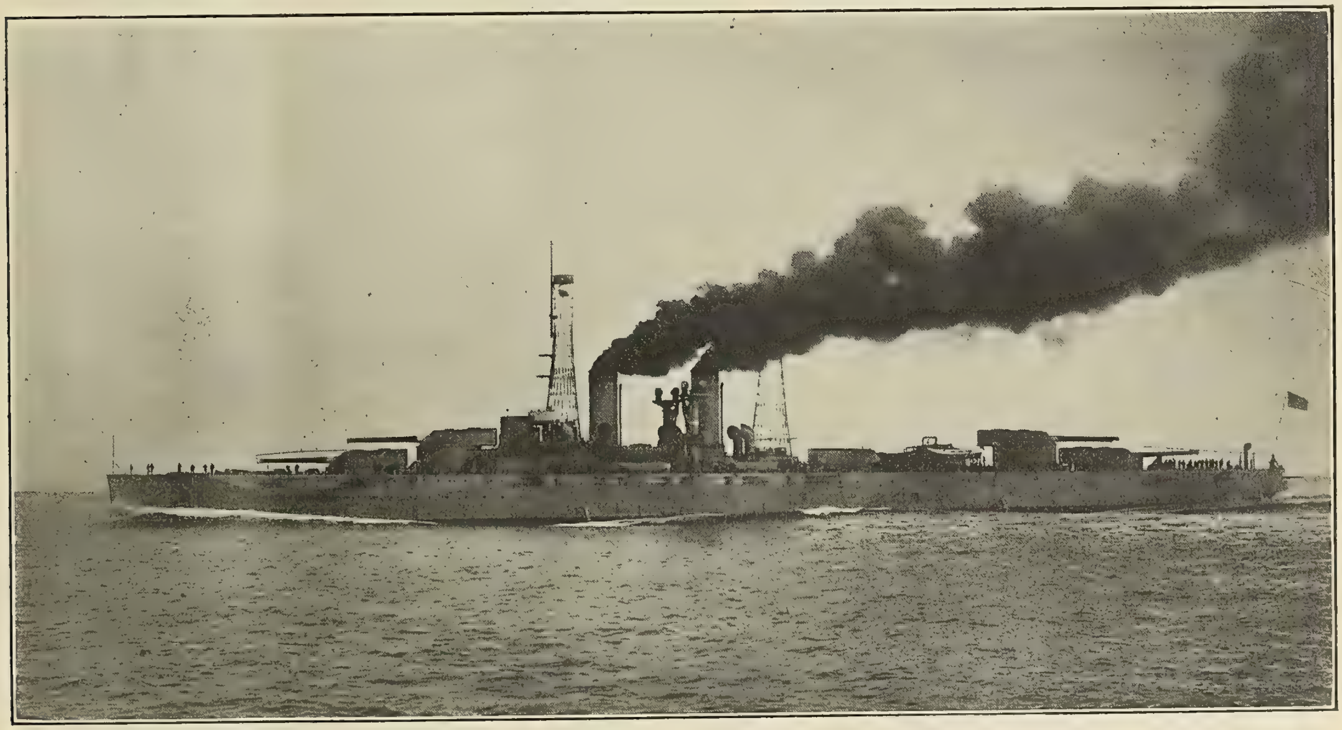


Fig. 1.—Battleship Texas; Average Speed at Full Power 21.05 Knots. (Photograph Copyright by N. L. Stebbins)

The batteries consist of ten 14-inch 45 caliber B. L. R.; twenty-one 5-inch 51 caliber B. L. R. and four 3-pounder saluting guns. There are four 21-inch submerged torpedo tubes.

The general outward appearance of the vessel may be judged from the illustration which is reproduced from a photograph taken on the trial.

Machinery Arrangement

The general arrangement of the machinery is similar to that of U. S. S. *Delaware*. It consists of the boiler space with three firerooms, having four boilers in each, and one fireroom with two boilers. Two smoke stacks carry off the gases of combustion from the fourteen boilers. There are two engine rooms, divided by a fore and aft bulkhead.

Boilers

The boilers are all of the Babcock & Wilcox make, eight of them having superheaters, while six are without superheaters. Each boiler is fitted for oil burning as well as for coal, either system being capable of being operated singly or together. The total generating surface, inclusive of superheating surface, is 65,480 square feet and the total grate surface is 1,554 square feet, making a ratio of 1 to 40. Forced draft is on the closed fireroom system.

Engines

There are installed two vertical inverted direct-acting triple-expansion engines driving twin screws. The specified power of the two main engines combined is 28,100 indicated horsepower when turning over at the rate of 125 revolutions per minute with a steam chest pressure at the high-pressure cylinder of 265 pounds gage without live steam in either receiver and a mean cut-off in the high-pressure cylinder of .82 stroke.

The general arrangement of cylinders is: Forward low-pressure cylinder, high-pressure, intermediate and after low-pressure, with the high-pressure cylinder leading, followed by the intermediate-pressure, forward low-pressure and after low-pressure in the order named. The high-pressure and forward low-pressure cranks are opposite and 180 degrees apart, which is also the case of the intermediate-pressure and after low-pressure cranks, each pair of cranks being 90 degrees apart.

All the cylinders are fitted with piston valves, one for the high-pressure, 22 inches diameter; two for the intermediate-pressure and each low-pressure 24 and 34 inches diameter, respectively; the travel of each valve being 10, 11 and 12 inches, respectively. The framing is built up of turned and finished forged steel columns, cross-braced and longitudinally connected, bolted to the bed plate and cylinder feet by means of heavy flanges. The valve gear is of the Stephenson type, double bar link middle suspended, open eccentric rods. The crank shaft is hollow forged, in two sections, and the bed plate is of cast steel in sections, bolted together.

The reciprocating parts of opposite cylinders are balanced in weight, and the inertia forces and weights of all piston valves are counterbalanced by fitting to each valve a steam-cushioned balance piston of the Lovekin type. Forced lubrication is provided for all main journals and sliding surfaces. The cranks turn outboard for ahead motion.

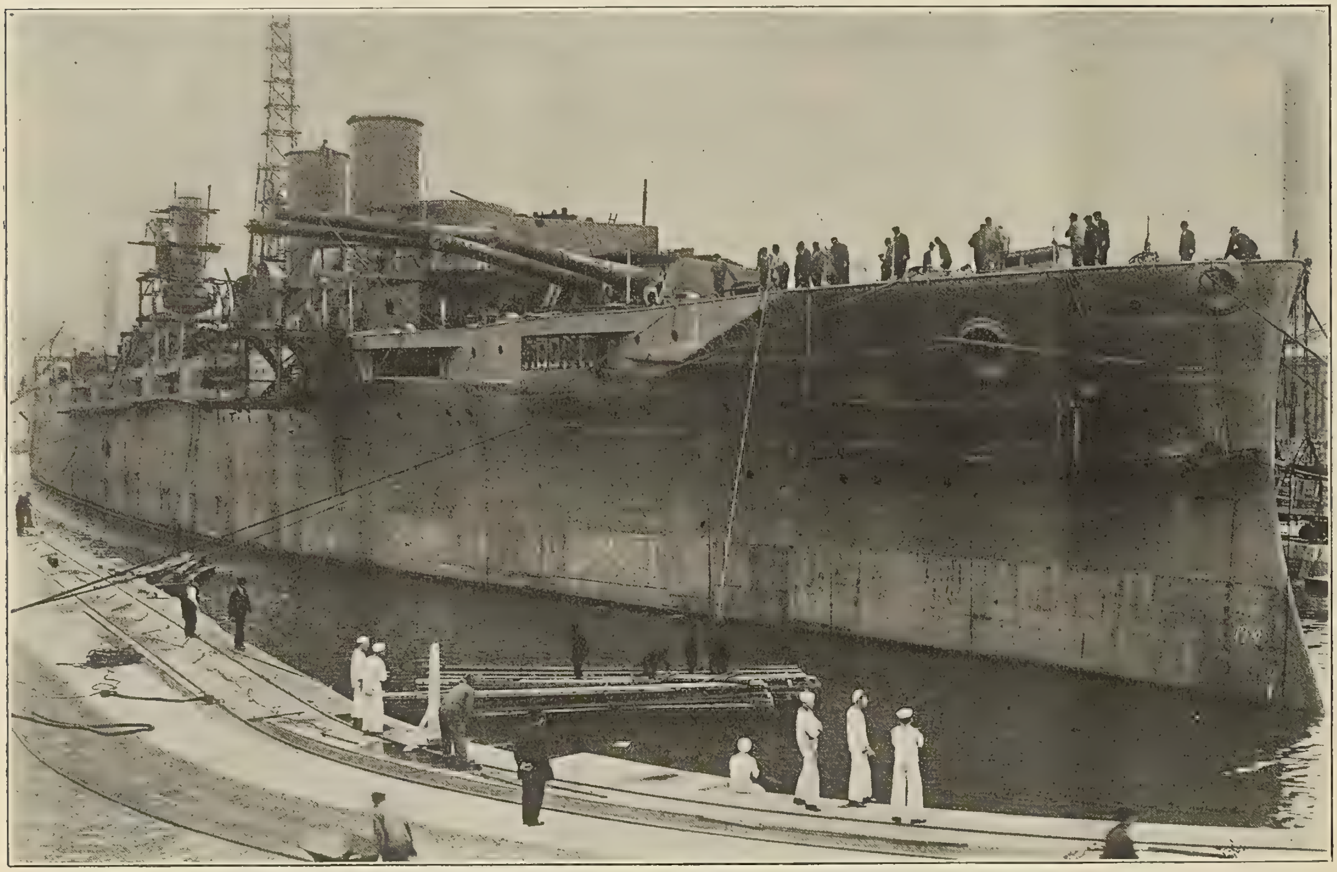


Fig. 2.—Battleship New York in Drydock at Brooklyn Navy Yard

The length of connecting rods is 96 inches with a crank ratio of 1 to 4. The cylinders are: High-pressure, 39 inches; intermediate-pressure, 63 inches and each low-pressure 83 inches in diameter, with a common stroke of 48 inches. Each intermediate-pressure and low-pressure cylinder barrel is jacketed.

The designed distribution of power among the various cylinders is such as to give about one-third the total to each high-pressure and intermediate-pressure cylinder and about one-sixth to each low-pressure cylinder. Despite the inequality in power between the cylinders the guides, piston rods and connecting rods, crossheads and crank pins are all made of uniform size. This greatly facilitates fitting and carrying of spare parts. The piston rings in high-pressure and intermediate-pressure cylinders are made solid, but the low-pressure cylinder piston rings are split and are provided with

means for attaining tightness. All valve packing rings are made with a solidly bolted joint, admitting of adjustment for wear.

The cylinder clearances are reduced to a minimum by using practically straight ports. The clearances range from about 12 percent at the top of the high-pressure cylinder to 17 percent at the bottom of the low-pressure cylinder. Piston rods and connecting rods, valve gear and other parts under great stress are made of 95,000 pounds tensile nickel steel; all shafting of 80,000 pounds nickel or carbon steel and propellers of manganese bronze.

The outside diameter of all piston rods is 8¼ inches, that of the thrust shafts 17¾ inches, crank shafts 18½ inches and propeller shafting 18¾ inches diameter.

The thrust bearings are of the horseshoe type, water cooled and fitted with forced lubrication.

CONDENSERS

There is installed one main surface condenser for each main engine with a total cooling surface of 13,104 square feet and two auxiliary condensers of 355 square feet of surface each, placed one in each engine-room. One dynamo condenser of 2,400 square feet of surface is placed in each dynamo room.

FEED HEATERS

Two Reilly multicoil feed heaters each of 295 square feet of coil surface are placed in the engine-rooms, one in each.

PROPELLERS

There is fitted on each shaft a 3-blade manganese bronze propeller, modified Griffith true screw, the diameter being 18 feet 7¾ inches, pitch 20 feet and the projected blade area 87.9 square feet.

AUXILIARIES

In each of the main engine-rooms are installed one circulating pump driven by a compound engine, one Blake vertical twin, single acting air pump, having 35 inches water and air cylinders of 21 inches stroke; two Blake vertical piston double-acting simplex feed pumps, with 9¾ inches water cylinder and 24 inches stroke. In each fireroom there is one auxiliary feed pump of the same type and size as the main feed pump. Besides the foregoing all necessary and usual auxiliaries, such as feed heaters, auxiliary and dynamo condensers, evaporators and distillers, with pumps, fire and bilge pumps, hot well pumps, air compressors, feed tanks, etc., are placed in the ship.

BLOWERS

There is arranged an independent electrically-driven blower set for each boiler, controlled from the boiler room. The motors may be run for a number of different speeds and are, together with the multivane fans, erected in airtight casings placed under the protective deck. These casings communicate with air locks and ventilators.

TRIALS

The standardization trials of the U. S. S. *Texas* were undertaken by the builders on Oct. 23, 27 and 28 on the Government standardization course off Rockland, Me. Of the specified trials the four-hour full-power trial was held Oct. 28, the 19-knot 24-hour trial on Oct. 30-31, the 12-knot 24-hour trial on Oct. 28-29, and the two-hour full-power combination oil and coal trial on Oct. 31.

FOUR-HOUR FULL POWER TRIAL

Steam pressure at boilers, gage		295.6
Steam pressure at engines, gage		271.1
Steam pressure at high-pressure steam chest, gage		246.4
Water used by all machinery per indicated horsepower hour of main engines, pounds		15.06
Coal used per hour per indicated horsepower of main engines		1.73
Average air pressure in firerooms, inches water		1.48
Average vacuum in condenser, inches		26.8
Average vacuum in condenser low-pressure cylinders, inches		24.24
Average revolutions per minute		124.56
	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	4326	4686
Indicated horsepower of intermediate-pressure cylinder	4275	4468
Indicated horsepower of fore low-pressure cylinder	2775	2479
Indicated horsepower of aft low-pressure cylinder	2927	2527
Indicated horsepower total, both engines		28373
Coal used, New River, picked, British thermal units, per pound		14970
Speed in knots		21.05

NINETEEN-KNOT 24-HOUR ENDURANCE TRIAL

Steam pressure at boilers, gage		284.9
Steam pressure at engines, gage		276.5
Steam pressure at high-pressure steam chest, gage		234.3
Water used by all machinery per indicated horsepower hour of main engines, pounds		14.47
Coal used per hour per indicated horsepower of main engines		1.53
Average air pressure in firerooms, inches water		
Average vacuum in condensers, inches		26.82
Average vacuum in low-pressure cylinders, inches		26.53
Average revolutions per minute		110.3
	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	2840	3014
Indicated horsepower of intermediate-pressure cylinder	3150	2971
Indicated horsepower of fore low-pressure cylinder	1764	1649
Indicated horsepower of aft low-pressure cylinder	1735	1656
Indicated horsepower total, both engines		18779
Speed in knots		19.078

TWELVE-KNOT 24-HOUR ENDURANCE TRIAL

Steam pressure at boilers, gage		285.5
Steam pressure at engines, gage		277.7
Steam pressure at high-pressure steam chest, gage		91.94
Water used by all machinery per indicated horsepower hour of main engines, pounds		17.37
Coal used per hour per indicated horsepower of main engines		2.01
Average air pressure in firerooms, inches water		
Average vacuum in condensers, inches		26.71
Average vacuum in low-pressure cylinders, inches		26.2
Average revolutions per minute		69.26
	Starboard	*Port*
Indicated horsepower of high-pressure cylinder	711	815
Indicated horsepower of intermediate-pressure cylinder	788	716
Indicated horsepower of fore low-pressure cylinder	420	394
Indicated horsepower of aft low-pressure cylinder	420	376
Indicated horsepower total, both engines		4640
Speed in knots		12.137

Besides the foregoing trials an additional full power trial

for combined use of coal and oil was carried out. This trial lasted for two hours.

The steering qualities as well as those pertaining to the seaworthiness of the vessel as developed during the trials were found in every respect satisfactory. The bearing temperatures throughout the trials were steady, no undue heating being prevalent in any of the working parts.

The splendid performance of the vessel from an economic viewpoint, aside from influences of a highly developed design and excellent workmanship, may incidentally be ascribed to steam conditions which show a fair degree of superheat in the high-pressure cylinders and dry saturated steam in the others. The following table gives an idea of what occurred:

Table I

Table of Steam Pressures and Temperatures

	H. P. Clyinder. Engine.	Steam Chest.	I. P. Steam Chest.	L. P. Steam Chest.	C'ndit'n of Steam H. P.	I. P.	L. P.
Pressure, gage	274	246					
Pressure, absolute.......			91.2	26.5			
Temperature, degrees F.	454.5		322	242.5	Sup. 40	Dry	Dry

An interesting comparison of steam consumption of the machinery of the U. S. S. *Delaware* and U. S. S. *Texas* may be partially inferred from the following table. It is, however, not possible to sharply define the relative economic performances of the main engines alone, as the separate data of water consumed by auxiliaries and main engines on the *Texas* were not obtained. But as the main engines of the *Texas* developed practically the same horsepower as did the *Delaware's* main engines, the horsepower of the auxiliaries of the two ships is probably nearly the same. Furthermore, as the type of the auxiliaries conforms very closely in the two ships, the steam used by said auxiliaries should be approximately the same. The steam consumption per indicated horsepower of the main engines on the basis assumed is given in Table II.

Table II

Full Power Trial

Comparative Table of Performances of U. S. S. Texas and Delaware

	Texas	*Delaware*
Steam pressure at valve chest, gage......	246.4	253.
Vacuum in condenser, inches............	26.8	26.3
Vacuum at low-pressure cylinder exhaust, inches	24.24	20.82
Mean referred pressure..................	44.08	50.9
Piston speed	996	1027
Live steam in receivers..................	No	No
Steam jackets	*	†
Cylinder ratio	9.00	7.92
Actual ratio of expansion...............	11.3	8.71
Superheat at high-pressure valve chest..	40° F.	61.6° F.
Forced lubrication	Yes	Yes
Steam consumption in pounds per hour per indicated horsepower of main engines, based on total steam used by main engines plus auxiliaries..........	15.06	14.79
Steam consumption in pounds per hour per indicated horsepower of main engines, based on total steam used by main engines only (estimated).........	13.64	13.32

*I. P. and L. P. cylinder barrels.

†All cylinder and top and bottom I. P. and L. P. barrels.

Shipbuilding Returns.—According to the monthly reports of the Bureau of Navigation, 83 sailing, steam and unrigged vessels of 12,687 gross tons were built and officially numbered in the United States during the month of November, 1913. Six of these, aggregating 2,441 gross tons, were steel steamships, all of which were built on the Atlantic Coast.

Unusual Shipbuilding Record in Russia

What is said to be a world's record in the annals of shipbuilding, both for the number of important ships launched and keel plates laid in a single town during two consecutive days, was made in the town of Nickolaev, Russia, on Oct. 31 and Nov. 1, 1913.

In Russia the expression "laying the keel plate" does not necessarily mean the actual operation of laying the keel from the builders' point of view, for it is applied to the official naval ceremony of placing a small silver tablet inscribed with the name of the vessel at some convenient place along the center vertical keel. This ceremony may be performed some time after the actual construction of the vessel has been commenced, although it is officially known as "laying the keel plate."

Programme for Two Days Mentioned

Keel Plates Laid

Oct. 31, two 1,000-ton destroyers; Nevsky Works.
Oct. 31, four 1,000-ton destroyers; French Works.
Oct. 31, three 700-ton submarines; Nevsky Works.
Nov. 1, two large cruisers; Russian S. B. Works.

Vessels Launched

Nov. 1, one 24,000-ton battleship; Russian S. B. Works.
Nov. 1, one 600-ton submarine; Baltic Works.
Oct. 31, two 1,000-ton destroyers; French Works.

All of the above events were confined within the town limits of Nickolaev, which is located at the junction of the Bug and Ingoul Rivers, about 40 miles up the Bug from the north shore of the Black Sea. Nickolaev has a population of about 150,000, and it is safely estimated that at least 100,000 persons witnessed the launching of the battleship and submarine on Nov. 1.

The yards at which these vessels are being built are located on the Ingoul River, and are directly opposite each other. The lofty south bank of the river curves around these shipyards in such a manner that it forms a colossal amphitheater, and offers an unobstructed view for witnessing the launches for more than a mile on either side of the works.

Besides the opportunity of witnessing two successful launches within thirty minutes of each other, the spectators were treated to a military and naval display of medieval pomp and splendor such as Russia alone can produce without the least affectation.

Hamburg-American Line's Despatch Tender

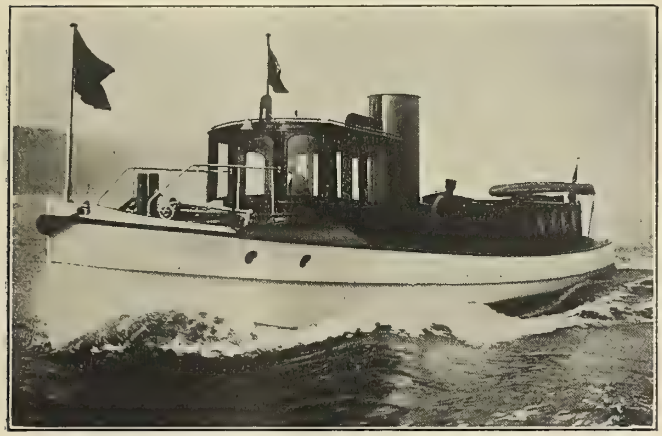
An interesting despatch tender has recently been added to the fleet of the Hamburg-American Line. This is a 60-foot steel steam launch, delivered this fall, having the distinction of bearing the name *Hamburg-American Line No.* 4. She was designed and built by the Gas Engine & Power Company and Charles L. Seabury Company, Con., Morris Heights, New York City, who developed a type of boat to be used the year round, to stand constant service in New York harbor, in all conditions of weather and harbor traffic, and to be capable of landing at all docks and piers.

The principal service of this boat is carrying company officials and despatches between the Hamburg-American Line piers at Hoboken and South Brooklyn, and at West Twenty-third street, New York City. It is necessary for this company to have the same party visit these same points practically every day. The tunnels, subways, ferries and surface cars combined proved to be a waste of much valuable time, and the inconvenience and delay were such that in some instances it was impossible to complete the trip, so this launch was called upon to remedy this trouble, and has proved herself to

be a success as a time-saver, a convenience and a comfort to the company.

The dimensions of the boat are: Length, 60 feet; beam, 10 feet; draft, 5 feet. The hull is built of steel, with steel watertight bulkheads. She is propelled by a Seabury marine steam fore-and-aft compound vertical engine, with cylinders 6 inches and 12 inches diameter by 9-inch stroke, steam for which is supplied by a Seabury patent safety watertube boiler. The launch has a speed of 12 knots.

The lines of the boat are those of a trim, seaworthy, staunch



Hamburg-American Line No. 4

vessel. There is a turtle deck forward, with hand rail. Next aft is a roomy pilot house built of selected mahogany, with plate-glass windows, giving the steersman excellent facilities for controlling the boat. The machinery compartment is arranged amidships. The after trunk cabin is built of selected mahogany, with side seats fitted with upholstered cushions. There is a toilet compartment in the forward part of the cabin, while next aft is a cockpit covered with a canvas khaki awning.

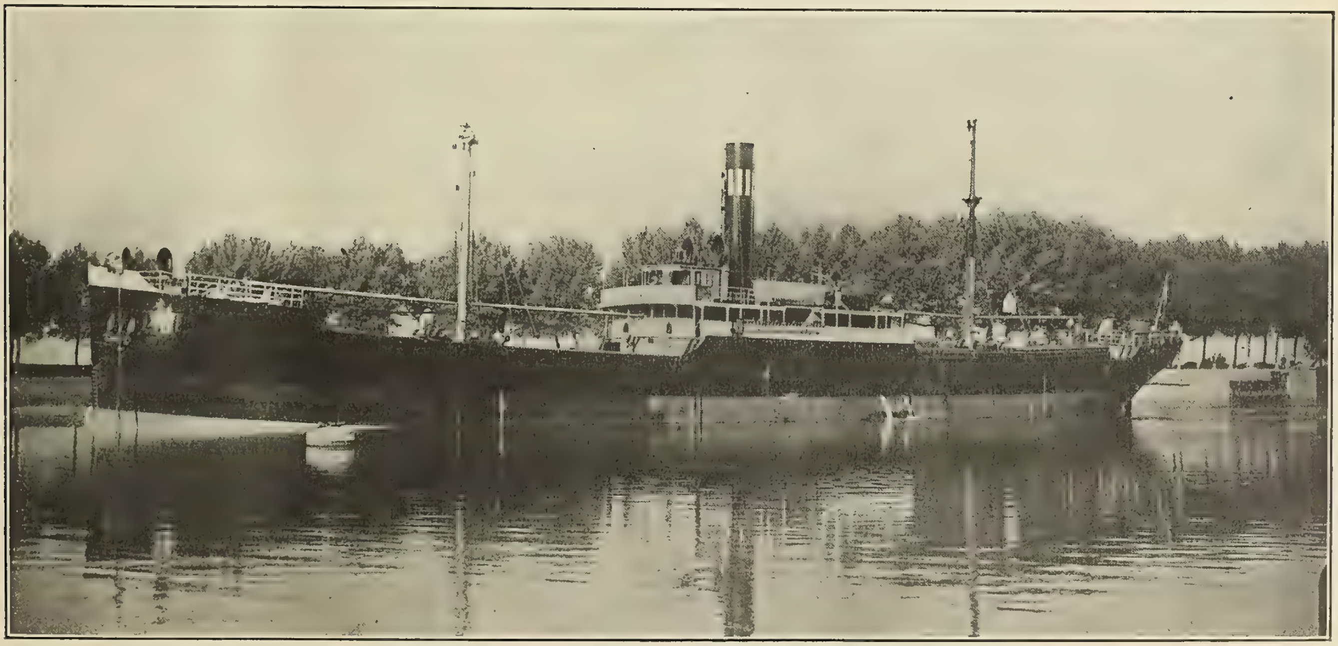
The *Hamburg-American Line No.* 4 is constantly seen ploughing her way between the liners, tugs and ferryboats under the most severe conditions in New York harbor and Hudson River, and makes a very creditable showing for a boat of her size.

Cargo Steamer Henriette

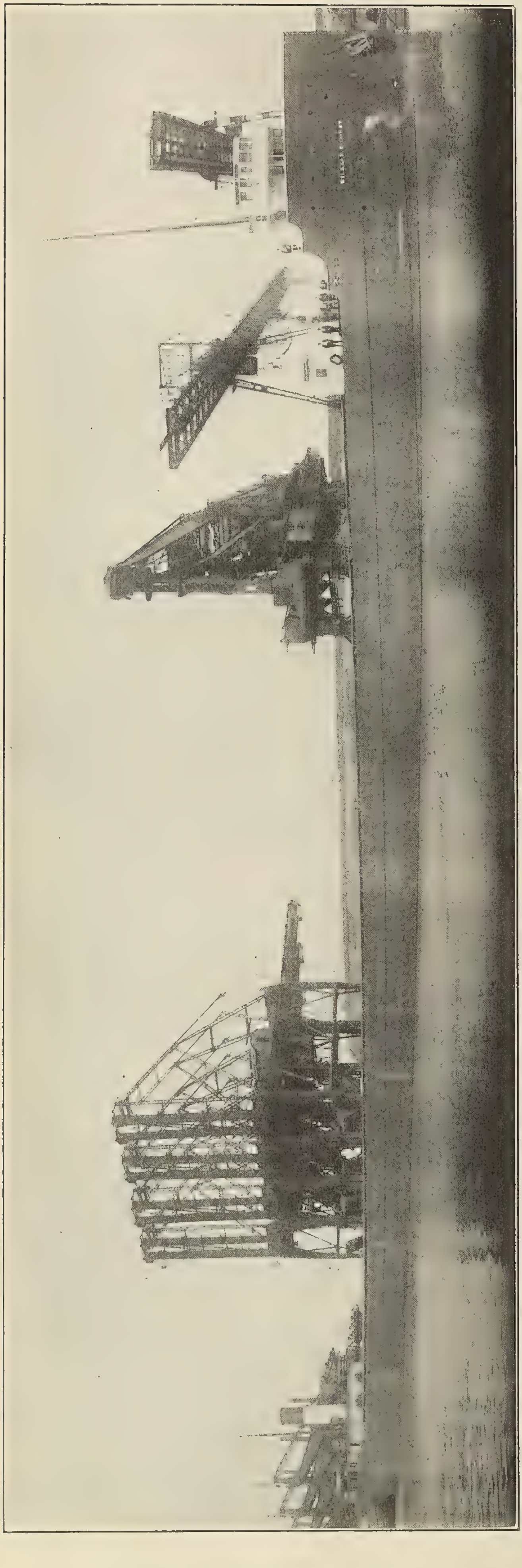
An interesting cargo vessel belonging to the new firm of Cie. Auxiliare de Navigation of Nantes and Paris, France, was built recently by the Ateliers & Chantiers de la Loire at their Nantes yard. The design of the vessel was worked out by the technical staffs of both the owners and builders. The dimensions are: Length over all, 278 feet 2 inches; beam, 39 feet 6 inches; draft, full load, 19 feet 9 inches; deadweight capacity, 3,105 tons; gross registered tonnage, 1,241; speed, 10 knots.

Deck View of Henriette

The hull is built with a double bottom, divided into five compartments, which have a total capacity of 485 tons of



Cargo Steamer Henriette, Average Speed on Trials 10.70 Knots



Lake Freighter William E. Corey at the Steel Corporation Docks, Connaut, Ohio

water. In addition, the fore-and-aft peaks have a capacity for 180 tons of water ballast. According to the plans of the owners, special water ballast tanks have been worked under the main deck in the fore-and-aft holds on both sides of the vessel. These tanks have a total capacity of 234 tons of water. Special pumps and piping have been provided, and without interfering with the double bottom tanks they can be filled with water in less than two hours. The object of these special tanks was to avoid heavy strains in both the hull and engines when running in ballast, as frequently happens in a vessel of this type when all of the ballast is carried in the double bottom. This type of construction also increases the strength of the hull and enables the builders to fit hatches of exceptional size, which are needed for the shipment of large pieces of machinery, etc., a class of cargo which commands the highest rates of freight.

There are four watertight bulkheads and each hold is divided by an ordinary steel bulkhead. Propulsion is by a single four-bladed propeller 14 feet in diameter and 11 feet 7 inches pitch, driven by a triple expansion engine with cylinders 18, 30 and 49 inches in diameter and 38 inches stroke. At 95 revolutions per minute the engine develops 1,200 indicated horsepower.

Steam is supplied by two single-ended Scotch boilers, working under a pressure of 185 pounds per square inch. The grate surface is 90 square feet and the heating surface 3,250 square feet. A special type of ash ejector is installed.

Each of the four holds is served by a four-ton steam winch and hollow steel derricks. An extra three-ton winch is fitted aft. The four hatches are of exceptional size and are fitted with coamings of exceptional height, more especially aft, where they extend above the ship's rail.

Record Breaking Freighter on the Great Lakes

BY L. O. WILLIX

Two noteworthy records on the Great Lakes are held by the steamship *William E. Corey*, of the Pittsburg Steamship Company. This vessel was built in South Chicago in 1905, and is one of the finest of the modern type of Lake steamships. Her principal dimensions are: Length over all, 569 feet; beam, 56 feet; molded depth, 35 feet. She has a carrying capacity of 10,200 tons on a mean draft of 19 feet 6 inches. This ship holds the world's record for quick loading, and during the season of 1912 she held the record for the number of miles traveled on the Great Lakes.

The best time made in loading the *William E. Corey* was at Two Harbors, Minn., where a cargo of 10,100 tons of iron ore was loaded in the steamer in twenty-eight minutes. During the present season the vessel has been in commission 206 days, traveling a total distance of 53,653 miles. During that time she burned 7,500 tons of fuel, carrying a little over 27,500 tons of iron ore.

The *Corey* is of the hopper-bottom type of construction, fitted with thirty-three hatches, spaced 12 feet between centers. She is equipped with two Scotch boilers and triple-expansion engines, with cylinders 24, 39 and 65 inches diameter with a common stroke of 42 inches. In light condition she is capable of attaining a maximum speed of 15 miles per hour, and when loaded a speed of 11.6 miles per hour. The best average run made during the past season was from South Chicago to Mackinaw, when she averaged 14.6 miles per hour for a period of 23 hours and 10 minutes.

In addition to her freight-carrying capacity, accommodations are provided in the deck house forward for eight passengers. The passenger accommodations include a galley, dining room, butler's pantry, sleeping rooms with bath rooms attached, a parlor, observation room and library.

All of these rooms are handsomely finished in quarter-sawed oak, excepting the dining room, which is finished in quarter-sawed birch. A duplicate installation of General Electric dynamos is provided for lighting the ship and heating the passenger quarters.

In the background of the picture of the *William E. Corey*, shown herewith, can be seen the "Hulette" ore unloading rigs at the Steel Corporation Docks at Conneaut, Ohio. While these machines are not the fastest machines on the Great Lakes, they are nevertheless capable of unloading one of the largest freighters in about four hours.

Relative Resistances of Some Models with Block Coefficient Constant and Other Coefficients Varied*

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

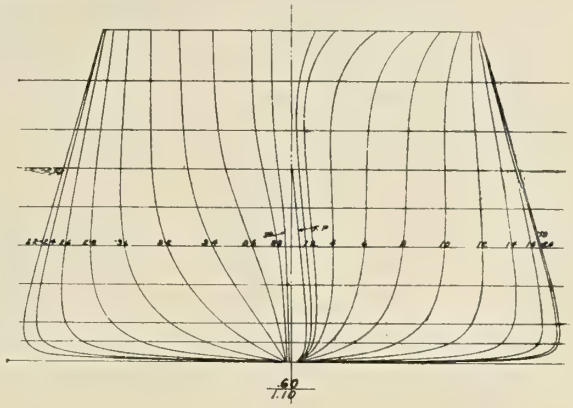
Five years ago I had the honor to read before the society a paper dealing with an experimental investigation into the influence of midship section shape upon the resistance of vessels. That paper, as was carefully pointed out in it, dealt with shape and not with area, the sectional area curves for the various shapes being identical. Moreover, it dealt with deep water conditions only.

In this paper I propose to give the results of some investigations where both shape and area vary, and where experiments were made in very shallow as well as deep water.

When in designing a new vessel we have fixed on dimensions and displacement, the block coefficient is fixed. But with a given block coefficient we may adopt a fine midship section coefficient with resulting full ends, or a full midship section coefficient with resulting fine ends.

In the experiments I am dealing with there were 20 models tested. There were four groups of five each, the block coefficients of the group being .56, .60, .64 and .68. The midship section coefficients used with each block coefficient were .86, .92, .98, 1.04 and 1.08. All models were 20 feet long, of 2,500 pounds displacement in fresh water, and 40 cubic feet immersed volume.

Table I gives the dimensions and coefficients for the 20 models. The ratio of breadth to draft was 2.4 in every case, and, of course, with variations of block coefficient there were corresponding slight changes in actual breadth and draft as indicated in Table I.



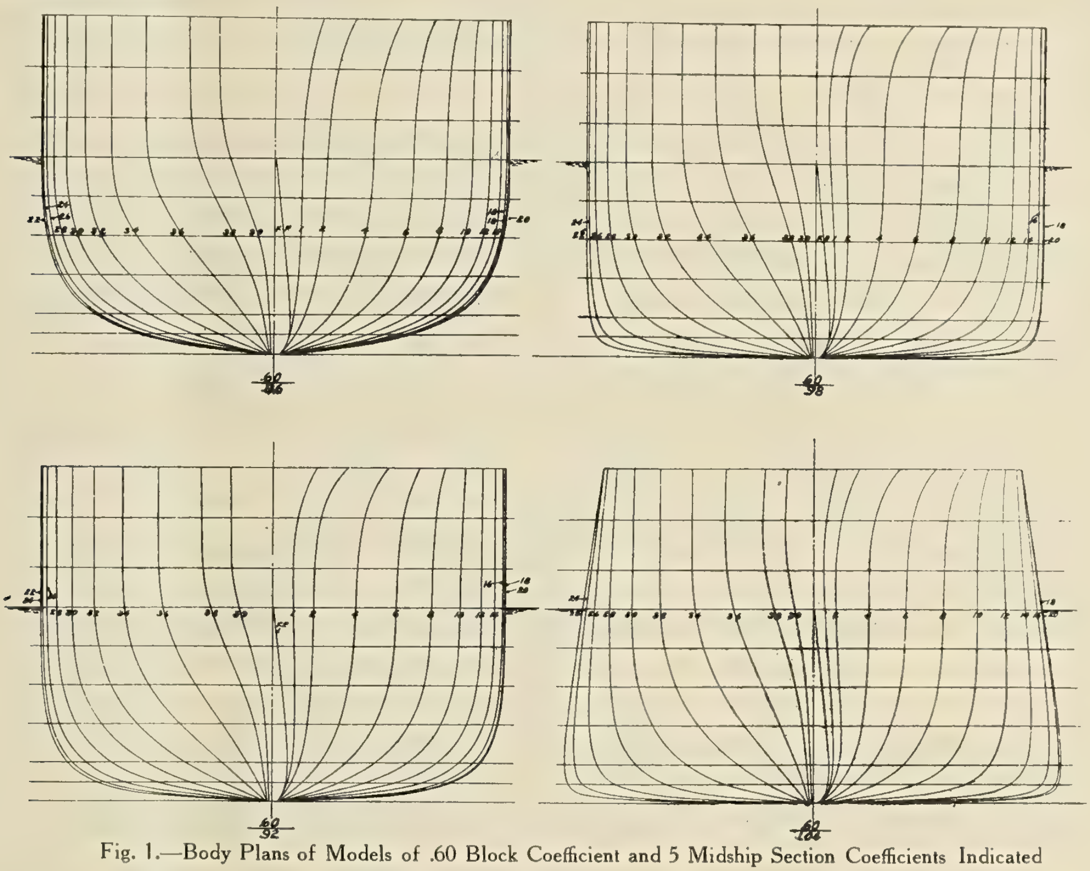


Fig. 1.—Body Plans of Models of .60 Block Coefficient and 5 Midship Section Coefficients Indicated

TABLE I.
DIMENSIONS AND COEFFICIENTS OF MODEL 20 FEET LONG AND 40 CUBIC FEET SUBMERGED VOLUME, OR 2,500 POUNDS DISPLACEMENT IN FRESH WATER.

Block Coefficient	Breadth	Draft	Midship Section Coefficient "m"				
			.86	.92	.98	1.04	1.08
b	B	H	Longitudinal Coefficients				
.56	2.928	1.220	.6511	.6088	.5714	.5384	.5091
.60	2.828	1.179	.6977	.6522	.6123	.5769	.5455
.64	2.739	1.141	.7441	.6956	.6530	.6153	.5818
.68	2.657	1.107	.7907	.7392	.6939	.6538	.6182

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

Fig. 1 gives the body plans of the five models of .60 block and having midship section coefficients varying from .86 to 1.08, the midship section coefficient being indicated below each body plan. The lines are not perhaps the best to be obtained for speed. Conventional lines we aimed at, although, desired, but by shifting sections forward or aft as required the form with the desired curve of sectional area is readily obtained.

It will be observed in Fig. 2 that the curves of sectional area have a small ordinate at the forward perpendicular. In

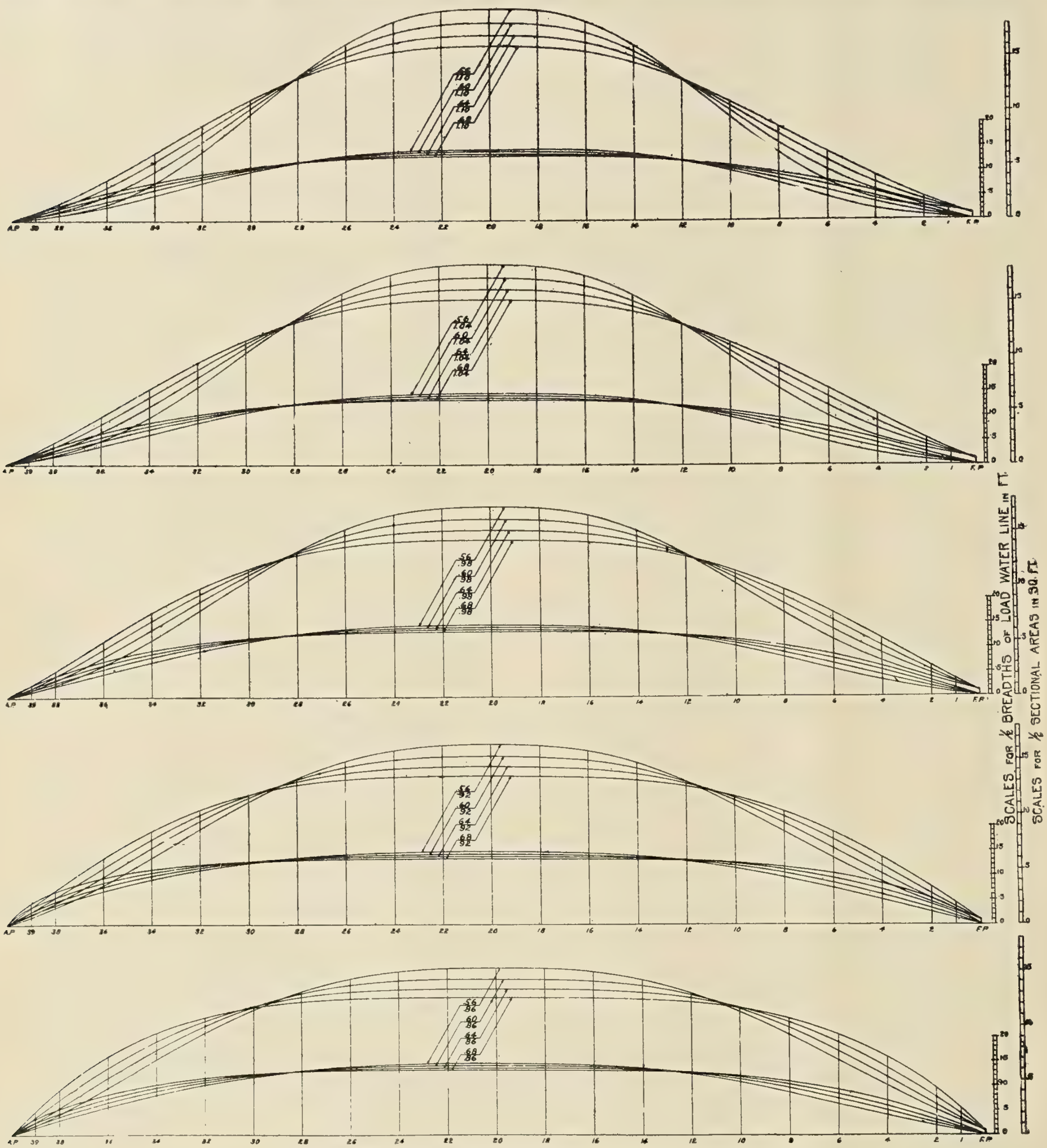


Fig. 2.—Waterlines and Sectional Area Curves for 20 Models

of course, the higher midship section coefficients are materially greater than used in practice.

Fig. 2 shows the water lines and sectional area curves for the 20 models. The body plans for the .60 block models shown in Fig. 1 may be regarded as the parent lines for the 15 models of the other block coefficients. The process of transition is simple. Starting with the .60 block model, imagine it expanded or contracted transversely until the midship section area is that for the new block coefficient. This expanded or contracted model will not have the curve of sectional area actually making the models the corners shown are rounded off on the model, the amount removed, however, being infinitesimal.

Fig. 3 shows contours of wetter surface coefficient plotted over the range of midship section coefficient and block coefficient of the 20 models. The wetted surface coefficient is the well-known coefficient C in the formula

$$\text{Wetted Surface} = C\sqrt{DL}$$

where D is displacement in tons in salt water, and L is water line length in feet.

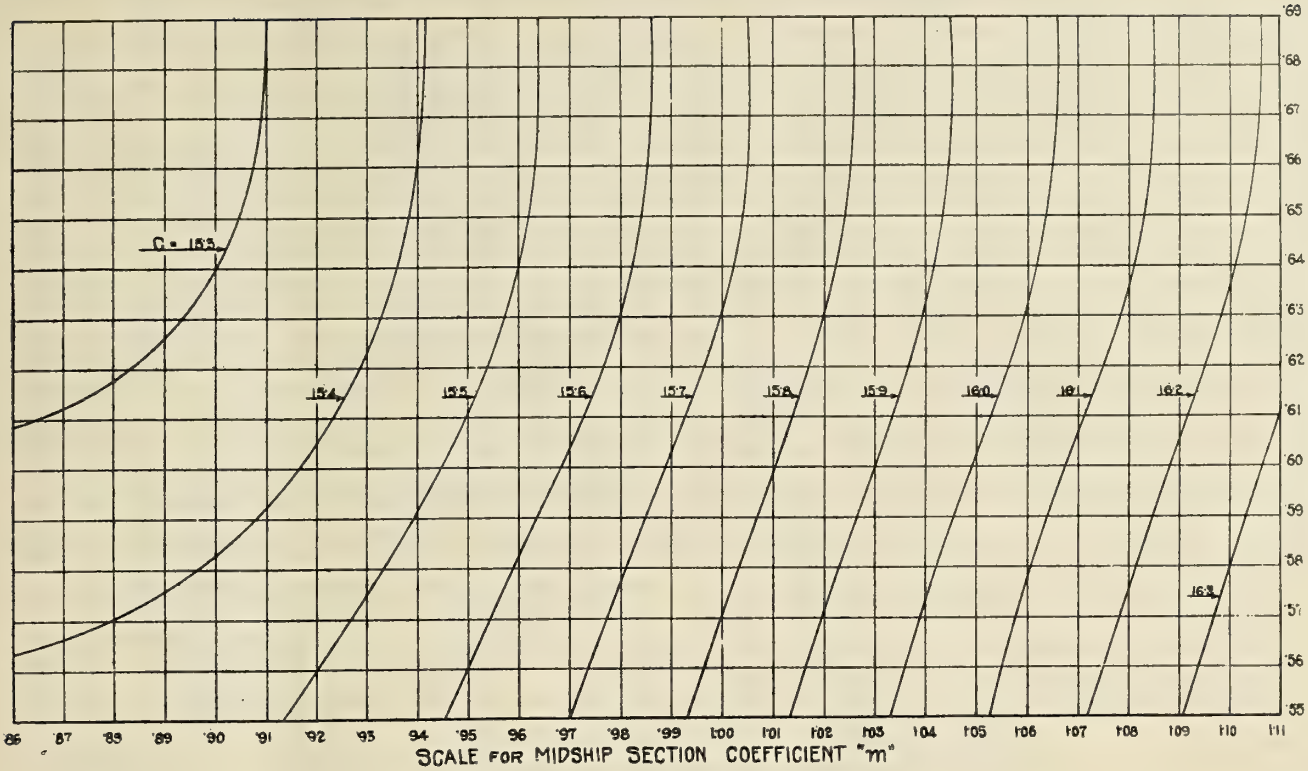


Fig. 3.—Contours of Wetted Surface Coefficient

The variation of C in Fig. 3 is as might be expected from what we already know of the effect of variation of form upon wetted surface. If we keep m constant and vary the block coefficient, b, there is very little change in the wetted surface; it decreases from $b = .55$ to about $b = .65$, but from .65 to .70 remains practically constant. If we keep block coefficient constant and vary the midship section coefficient there is appreciable variation of wetted surface for all blocks, the maximum for a range from an m value from .86 to 1.10 being about 6 percent. The fact that wetted surface coefficient diminishes from about 16.3 when m equals 1.10, to about 15.3 when m is equal to .85, or thereabouts, should not lead us to conclude that a smaller value of m will involve further material diminution in the wetted surface coefficient. As a matter of fact, 15.3 is very close to the minimum wetted surface coefficient obtainable, and if we continued to decrease m we would find the wetted surface beginning to rise again.

The 20 models were run in the usual way in the full depth

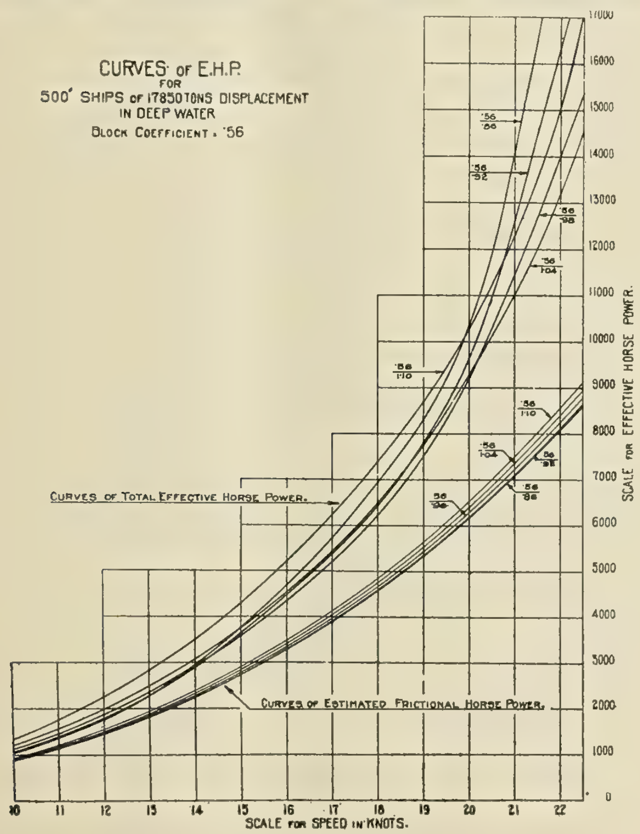


Fig. 4

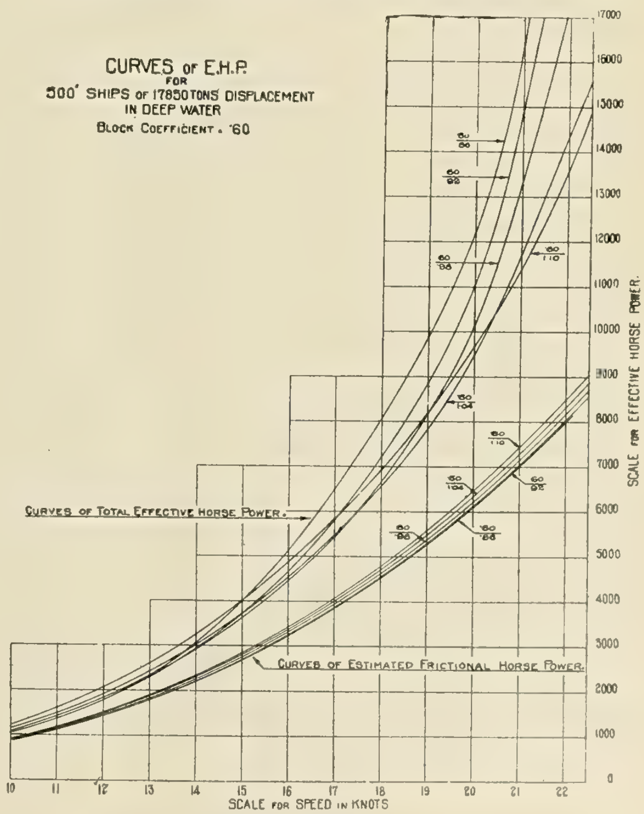


Fig. 5

of the model basin—14 feet in the center—and were afterwards tested, with a false bottom in place, in water 20 inches deep. The results are given in Figs. 4 to 12.

Figs. 4, 5, 6 and 7 give results as curves of effective horsepower in deep water for 500-foot ships displacing 17,850 tons upon the lines of the model. One figure is given for each block coefficient, the five curves in each figure referring to the five models of varying midship section coefficient.

It will be observed that except for very low speeds, where the smaller wetted surface associated with the fine midship sections has predominating influence upon resistance, the least effective horsepowers are found associated with the large midship section coefficients. In fact, for the vessels of large block coefficient less power would be required with midship section coefficients greater than unity. I think, however, we may safely say that the small powers found associated with the large midship section coefficients are not due entirely to the large coefficients. The larger midship section areas resulting from the larger coefficients enable us to obtain finer ended vessels, or vessels of finer longitudinal coefficient, and this more advantageous longitudinal distribution of displacement for the speeds at which tested helps to reduce the power.

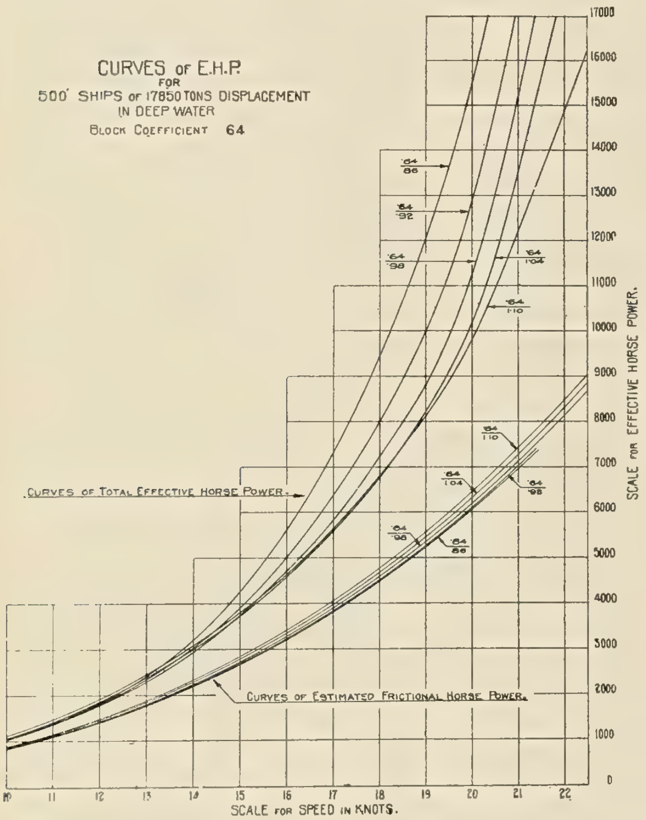


Fig. 6

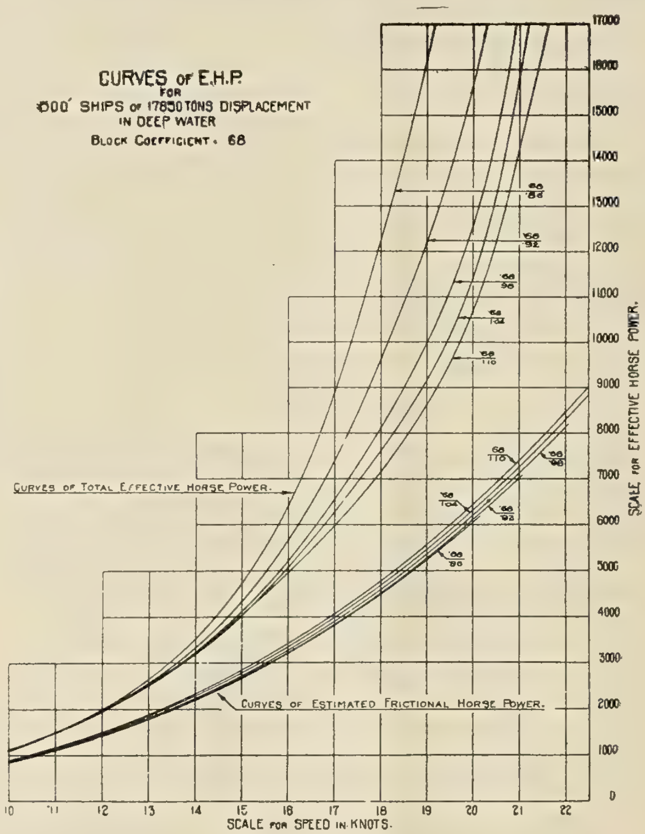


Fig. 7

I come now to shallow water results. The depth of water over the false bottom was 20 inches, while the draft of the models, as shown in Table I, varied from a little over 13 inches to about 15 inches, leaving comparatively small clearance under their keels.

It was found impossible to obtain consistent results for these models if they were run at speeds appreciably above three knots. At such speeds unstable eddies caused resistance for a given speed to vary radically. Accordingly these models were tested up to three knots only, and even then the results were materially more erratic than in deep water and required some cross-fairing of the experimental spots to make them consistent.

In Figs. 8, 9, 10 and 11 will be found shallow water results expressed as curves of effective horsepower for vessels 300 feet long, of 3,857 tons displacement, and in water 25 feet deep. Examination of these curves discloses the fact that in this shallow water the large midship section coefficients are at a disadvantage. Except for the highest block coefficient the curves of effective horsepower arrange themselves in order with the smallest midship section coefficient at the bottom.

There is another material departure from the deep water results. In deep water, broadly speaking, the finer the block coefficient the less the effective horsepower, but in the shallow water the effective horsepower at 10 knots, for instance, is very materially greater for the vessels having a block coefficient of .56 than for those having a block coefficient of .64.

The differences between deep and shallow water are perhaps more clearly brought out by Fig. 12, which shows curves of residuary resistance in pounds per ton plotted on

$$\frac{V}{\sqrt{L}}$$

Needless to say that the higher the curves for each block coefficient are for shallow water. The difference is quite remarkable.

I should like to explain the shallow water results, but this is almost the first systematic investigation which we have been able to make of shallow water resistance and I do not feel that the data so far obtained are sufficient to enable any final conclusions to be drawn.

It is obvious that the full-ended models run materially better in this shallow water than the fine-ended models. We know that for very high speed in deep water the same thing occurs, namely, that full-ended models are superior to fine-ended models. This is the case at, for instance, speed length ratios of 1.5 and over. It may be that in the shallow water the same type of form drives easiest at low speeds.

Another possible explanation is that in shallow water the shape of the midship section has the most material influence upon the resistance and that the low resistances associated

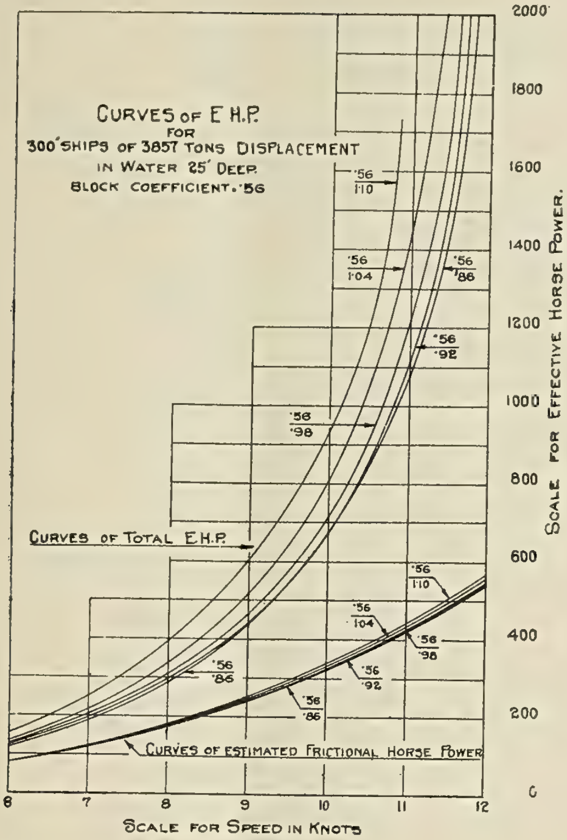


Fig. 8

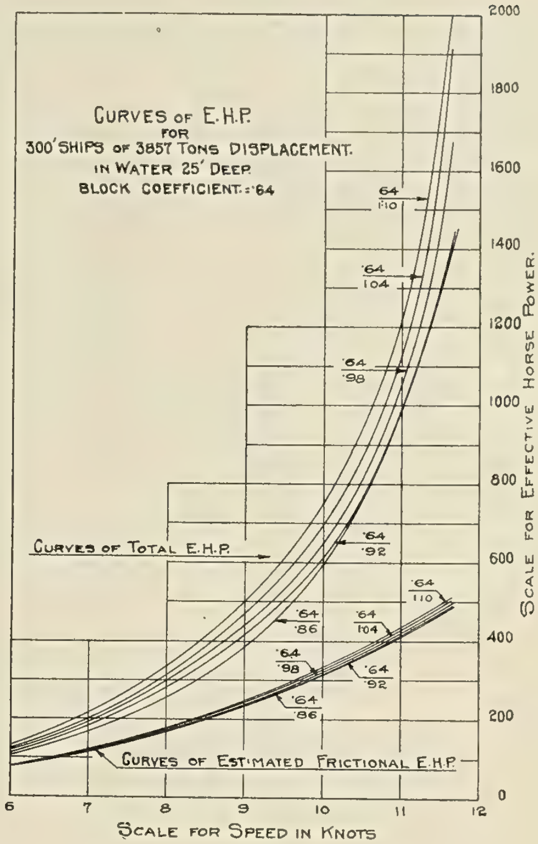


Fig. 10

with the fine midship sections are due mainly to these fine sections and not to the accompanying full ends. If this is the case the coefficient of midship section has a different effect upon resistance in shallow water from which it has in deep water. My 1908 paper showed clearly that for the speeds we are now considering in deep water the full midship section coefficients were favorable to speed.

If I must venture one conclusion, which seems warranted

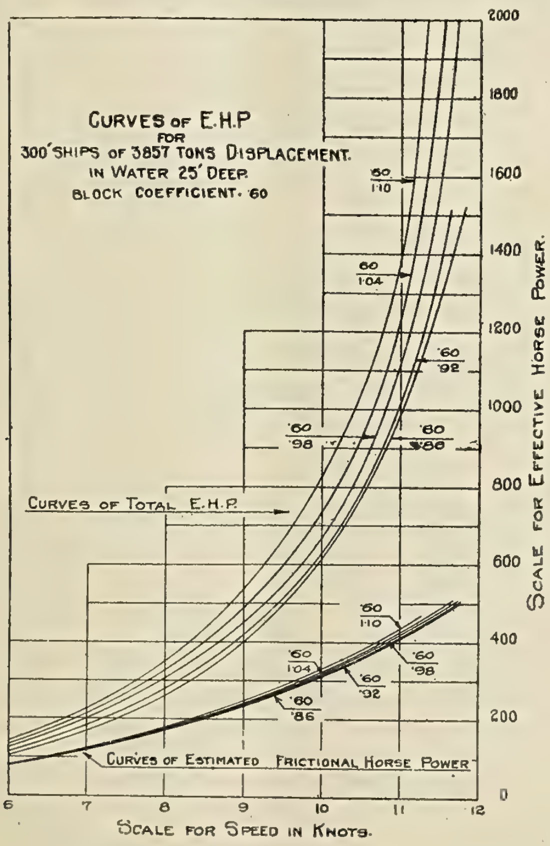


Fig. 9

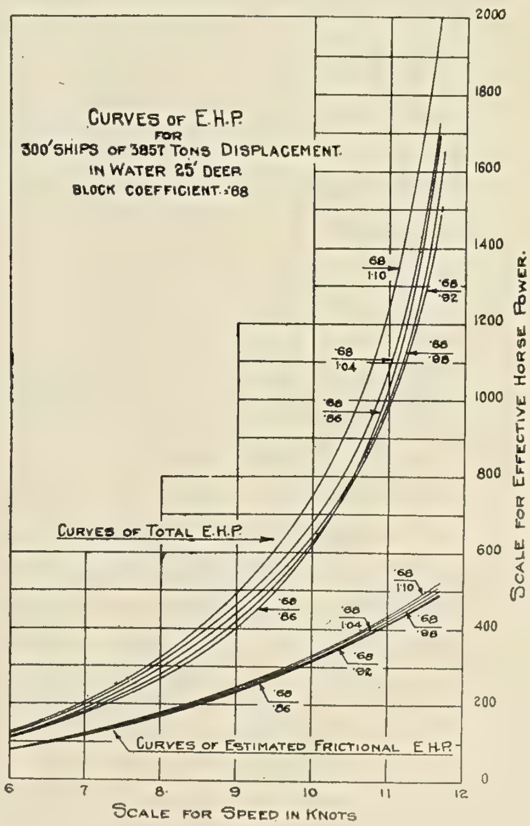


Fig. 11

by the shallow water experiments, it would be that unless for excessively shallow water there is probably no gain as regards resistance by adopting a midship section coefficient materially below .90.

It will be observed that even for the very shallow water in

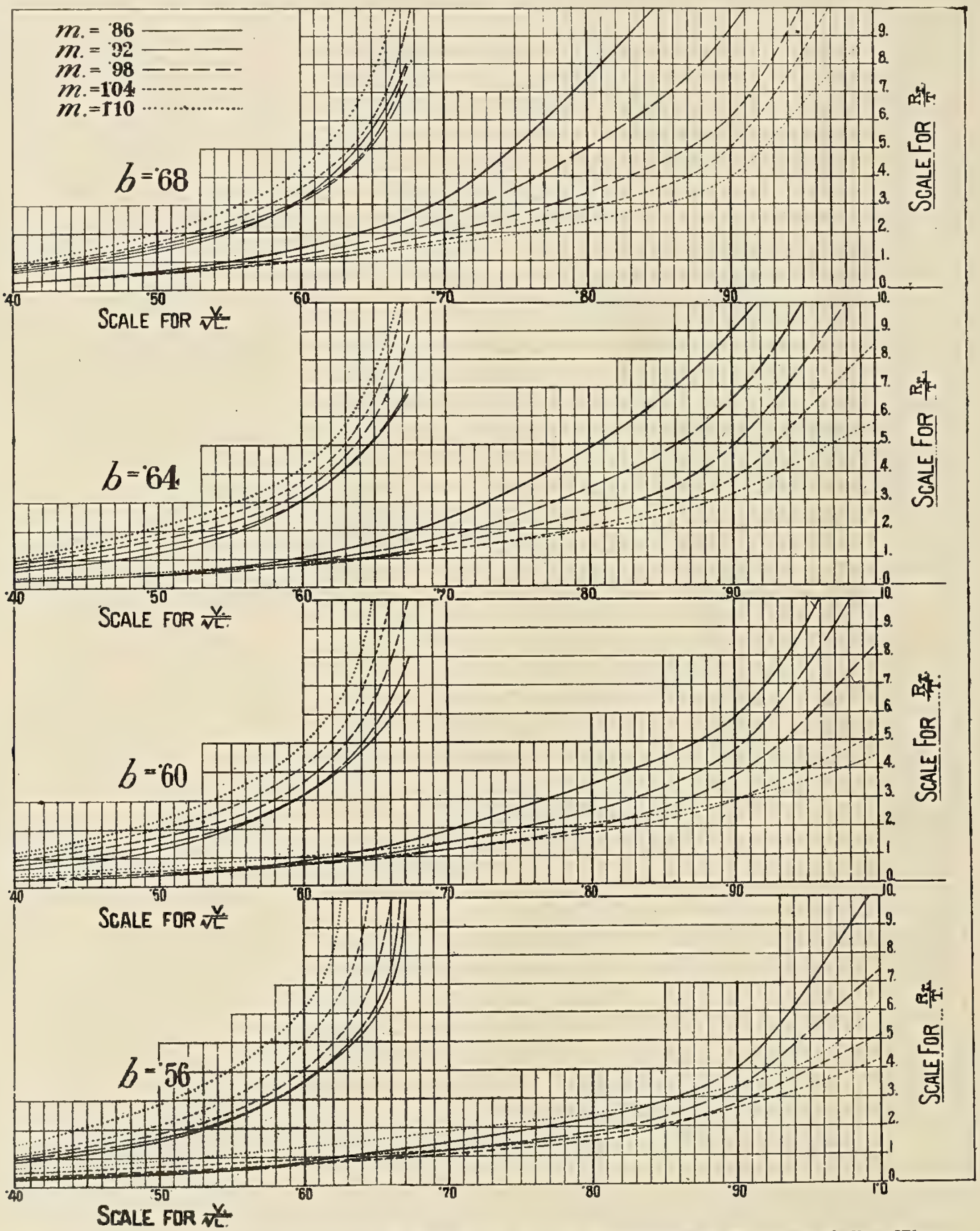


Fig. 12.—Curves of Residuary Resistance in Pounds per Ton of Displacement in Deep and Shallow Water

which these models were tested there was very little gain in dropping from midship section coefficient of .92 to one of .86. I would anticipate that as the water deepens the larger midship section coefficients would show a steady gain, and that for any depth of water greater than, say, 1¾ times the draft there would be no advantage from the point of view of resistance in adopting midship section coefficients below .90.

Pending systematic investigation of the features of form associated with minimum resistance in various depths of water it would seem that there are possibilities of great gain by careful model basin investigations of vessels of importance intended for shallow water work.

Obituary

Christian F. Olsen, naval engineer, for the past eighteen years in the employ of the Herreshoff Manufacturing Company, of Bristol, R. I., died Nov. 21 after a brief illness at his home in Bristol, aged 51 years. Mr. Olsen received his education at the Engineering Institute of the Royal Danish Navy in Copenhagen. His death is deeply regretted by his many friends in Denmark as well as in this country.

Samuel J. P. Thearle, D. Sc., chief ship surveyor of Lloyd's Register of British and Foreign Shipping, died at his residence, Croyden, Nov. 13, at the age of 67. Mr. Thearle was one of the early graduates of the Royal School of Naval Architecture. After several years' service as draftsman in the Admiralty he became a surveyor to Lloyd's Register of Shipping, becoming chief ship surveyor for them in 1909.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER XVIII

Care and Management of Boilers

For several weeks there had been an enforced vacation in the Floating School, the reason being that the work of installing the new boilers on the *Tuscarora* had been rushed night and day in order to get the ship out in time for the heavy trade in the autumn months. The members of the school had been kept so busy that they had but little time for study, and Chief McAndrew, of course, had so much to attend to in the thousand and one details a chief engineer has to think of that he had no opportunity to give the young men any attention. The repair work was finally declared completed; a dock trial had been held and the new boilers found satisfactory. The ship was to sail early the next morning; O'Rourke and Schmidt had been given two hours' liberty, in which time they had taken a fond farewell of their Fishtown girls. Nelson and Pierce denied that they had any particular sweethearts in Philadelphia, but they had enjoyed their stay in that place so much that they were somewhat loath to leave.

A full crew had been shipped for the engineer's department, and the Chief had so arranged it that all of his pupils would be in one watch. Much to his gratification, Jim Pierce had been promoted to be an oiler. Gus Schmidt had been given a boost by being signed as a water-tender, which led O'Rourke to remark that it must have been because he was so fond of water. Nelson and O'Rourke were still retained as firemen, but the Chief had promised them that if they paid close attention to business they would be given the first vacancies as water-tenders.

The Chief, of course, having three assistants, stood no watch, and he very kindly agreed to continue his classes at such intervals while the four aspirants for licenses were "off watch," as it might be convenient for him to spare them a little of his time.

The ship proceeded down the Delaware River on her way to New York, and as the four young men stood the 8 to 12 watch, McAndrew said he would give them an hour or so of his time that afternoon. The school was quite a mystery to the other men in the engineer's crowd, and some of them were inclined to be a little facetious about the four "high brows," as they termed them. However, as information regarding the school was imparted to them almost simultaneously with an exploitation of the fact that O'Rourke had been awarded several prizes as a heavyweight boxer at an East Side resort, the tendency to sarcastic remarks rapidly dwindled.

On addressing his class that particular afternoon, McAndrew stated that as the ship was now at sea, and was to continue on her regular duties, he would take up the subject of the care and management of machinery, and naturally would begin at the boilers.

"Before starting fires under boilers," he said, "we must first examine everything connected with them. See that all stems on the stop valves, check valves and blow valves are oiled, and that the valves can be worked freely. The safety valve gear should be put in good working condition, and the valves raised slightly off their seats. The air cock at the top of the boiler should be opened, or if none such is fitted, open the top gage-cock in order to allow the air to escape. See that the grate-bars are all in place, that the damper works freely, that the handhole and manhole plates are set up tight, that all necessary fire tools are on hand, that the bunker doors are opened, and that the surface and bottom blow valves and drain cocks are closed tightly.

* Engineer-in-chief, U. S. Revenue Cutter Service.

"If steam has not been raised on any of the boilers so as to allow the running of the pumps, the boilers should be filled by means of a hose from the deck, through the top manhole plates. It is only necessary to fill the boiler up to about two-thirds of a glass, as the water 'swells,' as the term is, when heat is applied to it. That is, in an ordinary boiler the water expands in volume as it is heated until it rises 2 or 3 inches in the glass. If no hot coals from another boiler are available, after throwing some coal on the bars, it is usual to start a wood fire at first and throw on a light covering of coal after the fire has commenced to burn freely. Soft coal catches fire comparatively easily, and so your fires will soon be burning in all the furnaces. In Scotch boilers great care must be taken not to force the fires and raise steam too quickly. It takes a long time to get the heavy shell plates warmed through uniformly, and if steam is raised too hurriedly the seams will begin to leak on account of the unequal expansion. For that reason it is usual to take from six to twelve hours' time in raising steam. One of the great advantages of watertube boilers is that steam can be raised rapidly without doing them any harm, as from their construction the water is rapidly circulated in all parts, and a uniform temperature throughout is easy to maintain. For that reason it is safe to raise steam in the average watertube boilers in a half hour if deemed necessary.

"The great disadvantage of all Scotch boilers is the large amount of water underneath the furnace which will not circulate naturally, and consequently remains quite cool even after steam is formed. To overcome this there are several patented devices which can be fitted to Scotch boilers, which will automatically circulate the dead water under the furnaces until the temperature is raised to very near that of the water above the furnaces. On ships which are not provided with such apparatus it is customary, if steam is available from another boiler, to run the auxiliary feed pump slowly, with its suction connected to the bottom blow, and its discharge entering the boiler through the regular feed pipe. This starts up a forced circulation and greatly facilitates the raising of steam.

"As steam begins to form slowly it will be first indicated by a slight hissing noise of the air escaping through the air-cock or the gage-cock. This air should be allowed to blow until clear steam can be seen escaping. Then the safety valves should be lowered, all cocks closed, and the steam pressure allowed to rise slowly, not over a rate of ten pounds an hour if there is no particular hurry about the operation. When the pressure rises to, say, 100 pounds, the auxiliary stop valve should be opened and steam admitted to the auxiliary line for the purpose of running the various auxiliaries.

"Having raised the steam to the working pressure, and put the boiler in service, the object of the engineer should be to keep it up to its highest state of efficiency; that is, to get out the most steam for the least expenditure of coal. To do this requires constant care and attention, for, like human beings, boilers respond readily to good treatment and rebel at harsh treatment. There are three principal things to do, which, if attended to intelligently, will keep a boiler in good condition. The first of these is to feed it with pure water; second, do not subject it to sudden changes of temperature, and, third, fire it properly.

"If these three maxims were lived up to there would be but little trouble. Unfortunately, however, they are difficult of accomplishment, and for that reason the average boiler is beset with many ills. Most of these arise from the quality of the water fed to the steel workman. In spite of precautions grease

will get in the feed water from the condensed steam; acids will be generated by the contact with the copper condenser tubes and feed pipes, and salt water will get in through leaks in the condenser tubes and pipe connections, and occasionally salt water will have to be fed to make up losses. It is these foreign elements in the feed water which make all the trouble."

"Yes," broke in O'Rourke, with a meaning glare at Schmidt, "and my father always used to say that it is the foreign elements that make all the trouble in this country."

"Is that so?" sarcastically replied Schmidt. "I'll bet it wasn't many days before you were born that he was tramping through Castle Garden himself."

"I don't suppose that any of us is eligible to join the Sons of the American Revolution," said McAndrew; "but that cuts no figure in this land of the free.

"As I was saying before being so rudely interrupted, if it were not for the impurities which get into the boilers the engineer would have but little trouble in keeping the interior surfaces clean. To counteract all these impurities is one of the main parts of an engineer's duty. Hence one of the first things to do is to ascertain how much salt water slips in from one source or another. Since steam vessels first plied the oceans, every one has been fitted with an instrument known as a salinometer—not 'salometer,' as I have heard O'Rourke term it. This word means literally salt measure, and at that it does not express its use correctly.

"Salt, of course, is one of the principal solids in salt water, but there are enough other chemicals in it to start a small drug store. In case any one ever asks you what salt water does contain you can refer to this analysis of the average sea water, as it contains the following parts in 1000:

Water	964.745
Chloride of sodium (common salt)	27.059
Chloride of potassium	.766
Chloride of magnesium	3.666
Bromide of magnesium	.029
Sulphate of magnesia (Epsom salts)	2.296
Sulphate of lime (plaster of paris)	1.406
Carbonate of lime (chalk)	.033
	1000.00

"Some chemists state that there is also a small quantity of gold in sea water; but I wouldn't advise any of you to buy any stock in a company formed for the purpose of getting gold from that source.

"Although the instrument I have referred to is called a salt measure, its real purpose is to determine how much solid matter is contained in the water. By adding up the amounts of all the solid ingredients in sea water you will see that they foot up approximately 1/32 of the entire weight of the water. That is, in 1 pound of salt water there would be 1/32 pound, or ½ ounce, of solids. Hence all salinometers are graded on that basis; 1/32 means salt water as drawn from the sea; 2/32 means twice as much solid contents as ordinary sea water, and so on.

"With every salinometer there is a small glass instrument weighted with shot known as a hydrometer. This instrument is usually graduated in divisions known as 32nds, which is based upon the principle that a floating body displaces an amount of water equal to its own weight. Hence the heavier or denser the water it floats in, the higher will be the portion out of the water. That is the reason that it is easier for a man to float in salt water than it is in fresh water. I have told you before that water expands when heated, hence its weight or density varies with its temperature. Therefore, to use the hydrometer correctly, the water to be tested must be at the same temperature for which the scale on the hydrometer is adjusted.

"On most hydrometers there are three scales shown—one at 190, one at 200 and the other at 210 degrees F. The method of testing is to open the cock and allow the boiler water to fill a brass vessel, known as the salinometer pot; if it is below 190 degrees F., as shown by the thermometer, admit sufficient hot water from the boiler to heat it up to one of the three temperatures shown on the scale. Then put in the hydrometer and observe how high it floats on the temperature scale corresponding to the temperature of the water. If you should hear some one say that the water is 2¼ or 2½, it would mean 2¼ thirty-seconds, or 2½ thirty-seconds, as the case might be.

"I have devoted some time to telling you about the salinometer and how to use it, but I will tell you very briefly that it is not of much value nowadays, as that method is too crude for modern usage. You might as well weigh drugs on a hay scale, so far as accuracy is concerned. There is in use on a number of ships a chemical process for determining accurately the amounts of the principal ingredients in boiler water; the apparatus is so simple that if the directions are closely followed any engineer can use it.

"Very few marine engineers allow salt water to be used for make-up feed in these days, hence it is not so essential to guard against scale-forming ingredients in the water. The principal causes of deterioration, such as rust and pitting, are due to the acids which get into the boiler water and thus encourage galvanic action."

"What's that?" blurted out O'Rourke.

"I thought you wouldn't understand it, O'Rourke, and so I used the term to arouse your curiosity. The word 'galvanic' is derived from the name Galvini, an Italian scientist, who first discovered that an electric current is set up by the action of one metal on another. You all probably know something about the ordinary battery used for generating an electric current. This consists of a glass jar in which are immersed pieces of zinc and copper; you have probably noticed that the liquid in which they are immersed is slightly blue in color, this being caused by putting in some crystals. The object of these crystals is to form sulphuric acid in which the chemical action between the copper and zinc is readily started, with the result that an electric current is generated; the further result is that the zinc is gradually eaten away by this action, and after a certain length of time has to be removed. Now if these two metals had been placed in a jar containing pure water there would have been none of this action taking place.

"Here, then, is the secret of boiler pitting and corrosion; the whole boiler, if the water is allowed to get in acid condition, becomes like an immense battery, or rather a collection of small batteries, as this action will take place between different parts of the steel of which the boiler is constructed as well as between a brass feed pipe and the boiler shell, only, of course, it will not be so rapid. Hence it is that for years past baskets containing zinc have been suspended in different parts of the boiler immersed in the water, as the zinc is much more easily attacked by galvanic action than are the steel and iron of the boilers. The zinc is therefore eaten away, and, theoretically at least, the various parts of the boilers are spared. Later investigations on the subject have developed the fact that even the use of zinc is not the best step to be taken, as that is simply remedying the effects without removing the cause. In other words, it is similar to trying to cure a headache for a drunken man after every night's jag instead of making him stop drinking the booze and preventing the headaches."

"I can understand that argument all right, all right," said O'Rourke, who had been, for him, paying very close attention to McAndrew's remarks.

"These later experiments which I refer to have been directed towards preventing the boiler water from getting into an acid condition, and thereby stopping galvanic action and rust. It is a well-known law of chemistry that alkalis will counteract or neutralize acids. Plain soda ash, or sal soda, as it is called commercially, is one of the best and cheapest of

the alkalis obtainable, hence that is the material best used for counteracting acids in boiler feed water. It is also used to "kill" grease and oils which get into the feed water. Soda and zinc have for many years been relied upon to correct all of the evils which beset marine boilers, and yet they continue to rust, pit and eat away.

"By a long and continued series of tests recently held, some curious facts have been learned regarding the use of soda in feed water. One is that a small amount of soda, about one-tenth of 1 percent, is less corrosive than neutral water, or water that is neither acid nor alkaline; another is that water above one-tenth of 1 percent, and up to 2.6 percent alkaline, is really more corrosive in its effect than water in its neutral state. Finally, these experiments demonstrated that water containing 3 percent and over of the alkaline solution is absolutely non-corrosive.

"But the addition of so much ordinary soda to a boiler in which necessarily there are some oils or grease, will invariably cause violent foaming, or priming, as it is sometimes called. This is prevented by mixing with the soda certain proportions of glucose and a substance known as 'cutch,' which is a form of tannic acid. These ingredients tend to prevent foaming and the formation of scale. These materials are combined in standard makes of boiler compounds, and if they are properly used there is little doubt but that pitting and rusting will cease to a great extent. In order to get a 3 percent solution of the boiler water it is necessary to add about 5½ pounds of this compound for each ton of water in the boiler.

"Heretofore the care of boilers has been very much on the order of quackery in dosing the human system with all kinds of patent nostrums. There are but few medicines given by doctors which really accomplish any good, and they have been developed by experimenting. Many a good man has lost his life by having various kinds of 'dope' tried out in his stomach, and many a good boiler has met an untimely end by ignorant treatment. Now the 'boiler doctors' are really studying the subject, and from this time on boilers will be given better treatment. You young men are coming into the business at a time when the new methods of treating boilers are being perfected, and I predict that by the time you get in charge of steam machinery you will know much better how to take care of your boilers than engineers have in the past.

"No matter how well you treat the boilers while running they must, at certain periods, be given an overhauling, and at such times the greatest care and attention must be given them.

"The fire surfaces must be thoroughly cleaned and all deposits of soot brushed off. The water surfaces must be given the closest attention, and particular care taken to clean all dirt and scale off the crown sheets or tops of the furnaces. As you all know, this is no easy job, especially with Scotch boilers, as the spaces in which a man has to work are necessarily cramped, the air he breathes is vile, and there is every condition which would make him shirk the work, yet if the cleaning and scaling are not done properly the boiler and the coal pile will suffer alike.

"To give you an idea of the bad effect of even a slight amount of scale on the heating surfaces of a boiler, you will be surprised, I know, to learn that a hard scale only one-twentieth of an inch thick reduces the efficiency of a boiler 11.1 percent. That is, if a boiler is scaled up to that thickness on its heating surfaces, for every hundred tons of coal consumed there will be an absolute loss of 11.1 tons in the steam-producing effect."

"That would very nearly pay the fireman's wages, wouldn't it?" inquired Nelson.

"Yes, and more than pay them, so you can see the necessity for keeping boilers clean.

"Soot on the fire surfaces has almost as bad an effect, so you can understand how important it is to blow the tubes while running."

"The company ought to pay us extra every time we blow tubes," suggested O'Rourke.

"That's where you are wrong, as usual, O'Rourke. Employers in these days pay people to look after their interests in every way, and because a man is a fireman doesn't mean that he is for the sole purpose of shoveling coal in the furnaces. It is the fellow who thinks what he can do to save his employers money by keeping the particular piece of machinery which he is handling up to the highest state of efficiency who gets promoted and carries away the most coin on pay day.

"When cleaning boilers it is very important that all the valves and attachments be given a thorough inspection and put in first-class condition. All screw valve stems should be oiled with cylinder oil and graphite, glands repacked, safety valve lifting gear oiled and made to work easily. Small pin-head leaks should be touched up with a calking tool as soon as they are noticed. A leak in a boiler should be treated in accordance with the old saying, 'A stitch in time saves nine.'

"Many people have the idea that a fireman to be successful need only be sufficiently strong to stand the heat and shovel coal in the furnace for a period of four hours at a time. That is a great mistake, as the successful operation of marine machinery depends more upon skillful firing than upon any other part of the business. No man can be a successful marine engineer unless he knows how coal can be burned most efficiently, and sees to it that what he knows in that line is put into force by the gang in the fire-room. The average fireman if left alone to follow his inclination will nearly always fill up his furnaces to the top, under the mistaken idea that a 'crown-sheeter,' as it is termed, makes the most steam. The average fire-room watch will, if not instructed otherwise, as soon as they come on duty clean their quota of fires, usually about one of every three, fill up the furnaces, then sit down and smoke for an hour or so. The boilers will also smoke under such treatment and make about as little steam as possible.

"In order to get the best results the following rules should be stuck to closely:

"Carry the fires for natural draft not over 8 or 10 inches thick; if forced draft is used they should be about a foot thick.

"Put on only two or three shovelfulls at a time in each furnace—throw it on quickly and spread it evenly over the fire.

"Never open more than one furnace door at a time, and close it just as soon as possible.

"Never throw in any lumps larger than a man's fist; have the coal passer exercise himself by using a coal maul on larger lumps before putting the coal in the furnace.

"Only use a slice bar to remove clinkers or ashes, and to keep the fires bright from the under side.

"Keep the ash pans clear at all times.

"Clean only one fire at a time, and so regulate the periods between cleanings that they come regularly, if the coal is of uniform quality; otherwise clean them whenever they get dirty.

"If the draft is strong and the coal very fine and dusty, sprinkle a little water on the coal.

"Keep the fires of even thickness by the use of the hoe or rake; level them off every other time that coal is thrown into the furnaces.

"Have each watch get out its ashes before being relieved, otherwise there will be a scrap with the next watch.

"In general, have everything done in the fire-room with some snap."

"In other words," butted in O'Rourke, "put some ginger into the work."

"Yes, that's it; let the 'ginger-snap' be the motto of the fire-room."

"It's more likely to be the hardtack," suggested the Hibernian.

"That's true, too, unless you use your brains as well as your muscles."

"Won't you tell us something about a water-tender's duties?" asked Pierce, who was feeling the responsibility of his new job.

"I was just coming to that," replied McAndrew. "The success of the fire-room depends largely upon the water-tender; the engineer of the watch may issue all the instructions about firing that he wants to, but he can't be in the fireroom all the time to see that they are carried out. Hence a rattling good water-tender is very necessary. Primarily he wants to be a man of nerve, quick to think and quick to act, and it's not a bad asset for him to be able to lick any fireman or coal-passer in his watch. Not that he should resort to tactics of that kind—far be it from me to suggest any such cruel procedure—but I have noticed in my several years of climbing that a water-tender who is handy with his fists generally keeps the ginger in the ginger-snap with his men. His principal job is to keep his mind on his duties during every minute he is on watch, and to keep his eye on the gage-glasses at least once every minute.

"He must also see that the furnaces are charged regularly in accordance with his instructions; that the fire-room is kept clean; that the coal is tallied; that the ash pans are hauled and the ashes blown out, and, in general, that all the routine duties of the fire-room are kept up. Ordinarily he should see that the water is maintained at about half a glass, and that the feed is so regulated by the check valves that it remains steady at that height if possible. As long as a boiler is under steam and the engines running, the feed should never be entirely cut off—no boiler has ever yet been blown up by having too much water in it, so there is no danger to the boiler even if you do put too much water in it—sometimes there is danger to the engine on account of foaming, caused by too much water. In general, the all-important thing to guard against in tending water is that there will always be water showing in the gage-glasses. Low water is the cause of 90 percent of all boiler explosions, and in nearly every case it is a direct result of carelessness.

"In case the water does get out of sight, as it will do at times in the best regulated fire-rooms, the first thing not to do is to get excited. No boiler ever has blown up immediately after the water has dropped out of sight. Keep cool yourself and try to cool the affected boiler. If you feel positive that the water level is only a little below the bottom of the glass, open the check valve wide and hold your breath. You may, during your first experience, think that it is taking about one month and ten days for the water to show up, but in reality it is usually visible in four or five minutes; then you can begin to breathe again. If, however, the water is out of sight, and you don't feel positive of the last time you saw it, close the damper; put up the ash-pit doors; shut off the main and auxiliary stop valves and the check valve and throw wet ashes or fresh coal over the fires to deaden them. Never haul the fires out until they have been deadened or extinguished by water, as stirring them up temporarily causes an increased heat, which might prove disastrous.

"In case of low water, the first thing, of course, is to try and remedy it by cutting out the boiler affected, as above described. But the water-tender must remember that the other boilers are still steaming, and he must not neglect to see that they are properly looked after, notwithstanding the temporary excitement on account of the crippled boiler. To sum it all up, a good water-tender must combine attention to business, quickness to act, and imperturbability of the highest degree."

This last qualification simply stunned O'Rourke, and while he was trying to recover from the shock the length of the word had given him, the Chief said: "I knew that would hold you, O'Rourke; but don't be alarmed, it simply means the quality of not getting rattled; you have your share of it.

"When the ship arrives in port and the boilers are to be out of use for several days, the fires should not be hauled, but simply allowed to die out gradually, so that there will be no sudden cooling of the boiler shell. It is usually advisable to give them a good blowing off from both the bottom and surface blows. After the steam is gone they should be pumped up full with fresh water, putting on a small pressure of 5 or 10 pounds to make sure that they are filled up. They should never be emptied by blowing off, as that causes too sudden cooling. If the boiler is to be cleaned the fires should be allowed to die out and the water pumped out after the steam has disappeared.

"If the boiler is to stand full of water for any length of time, the water should be made alkaline, so as to prevent corrosion as far as possible.

"If the ship is to be laid up great care should be paid to putting the boilers in such condition that they will not deteriorate. The grate-bars and furnace fittings, ash pans, etc., should be taken out and stacked up in the fire-room, out of the way but in a convenient position to be replaced. The interior of the furnaces, the combustion chambers and the tubes should be thoroughly brushed and cleaned to remove all soot and ashes. They should then be given a coating of black oil all over. The inside or water surfaces should be thoroughly cleaned and then thoroughly dried out by starting a light wood fire in the furnaces for a few moments, and by burning pans of charcoal inside the boiler. Some people prefer to fill the boilers up solid with water when they are to be laid up for several months, but I prefer to have them laid up dry as I have described. All the valves should be overhauled; put in good condition, and the valve stems coated with heavy oil or grease. A hood should be placed over the smokestack in order to keep the rain from leaking down and running into the up-takes.

"I could tell you lots more about the care of boilers, as you must remember that it is almost an inexhaustible subject. However, I have touched on the high spots of care and management, and you must learn much more by reading and from experience, the greatest teacher of all."

"They say old Experience is a hard teacher," suggested O'Rourke.

"You will find that he is if you don't follow the rules of his school."

"What are they?"

"His schools on board ship require diligence, energy and sobriety; if those three are lived up to you will find the old fellow is rather an easy teacher."

Launch of the French Liner Flandre

The latest addition to the fleet of the French Transatlantic Company was launched Oct. 31 by the Société des Chantiers & Ateliers de St. Nazaire (Penhouet) at their Atlantic yard. This vessel was christened the *Flandre*. She has been specially designed for the St. Nazaire-West Indies service and will be one of the most luxurious and speediest vessels on this service.

Contrary to the usual method of launching at the Atlantic yard, the vessel was launched on a single launching way. Her weight at the time of launching amounted to 3,800 tons. The total length of the stationary way was 499 feet and its width 40 inches. The sliding way was 414 feet 5 inches long and 36 inches wide, therefore the pressure on the ways at the time of launching was equal to over three tons per square foot. The declivity of the ways was 6 percent.

The main particulars of the vessel are as follows:

Length over all	480 feet 4 inches
Length between perpendiculars	459 feet 4 inches
Beam	57 feet
Depth to main deck	37 feet 1 inch
Draft, full load, aft	23 feet 8 inches
Displacement at load draft	11,330 tons
Gross registered tonnage	8,460
Designed speed	18.5 knots

A double bottom, divided into twelve compartments, hav-

ing a total water capacity of 1,000 tons, has been worked from end to end of this ship. The hull is further sub-divided by ten watertight bulkheads and there are seven decks, four of which extend from the stem to the stern.

The propelling machinery is of the type especially in favor in this yard, and which has been used with marked success on the steamships *Rochambeau, Lutetia,* etc. The machinery consists of two triple expansion four-cylinder main engines, driving the inner shafts and exhausting into two Parsons reaction turbines designed for ahead working only, driving wing propellers. Steam is supplied by six single-ended four-furnace Scotch boilers working at a pressure of 200 pounds per square inch under Howden's system of forced draft. The boilers are arranged in two compartments, each boiler-room having a separate funnel extending 98 feet above the grate bars. The total heating surface of the boilers is 28,600 square feet.

The passenger accommodations are arranged as follows: On the main deck are the second and third class accommodations and also quarters for the engineers, firemen and servants. On the deck above are first class staterooms and the main dining room. On the promenade deck are first class staterooms and on the awning deck special suites, together with the first class social hall, smoking room and café. The officers are quartered on the boat deck.

Old-Time War Vessel on the Great Lakes*

BY NEIL WILBER** AND LANDIS ISAACS†

The paddle wheels are of the built-up type, 22 feet diameter with 16 wooden stationary paddles, 16 inches by 96 inches by 2 inches thick. There are three cast iron spiders keyed to the shaft with 3-inch by ½-inch steel bars bolting into them for carrying the paddles. They have the necessary rim bars and tie rods. There is also a brake and brake band on the inboard spider, for locking the wheels to keep them still for inspection or while at a dock in bad weather, to eliminate noise.

Boilers

The *Wolverine* has two boilers of the leg type. These were installed in 1892, and up to the present time have given no trouble whatever. The first boilers installed in the *Wolverine* at the time the vessel was built lasted fifty years, and were replaced by the present boilers. The first boilers were, so to speak, half-and-half, because they were part watertube boilers, as shown in the sketch, Fig. 12.

This sketch also shows the peculiarities of their construction. There is a long furnace extending the full length of the boiler with a combustion chamber at the back. The gases of combustion return to the stack on the outside of a series of tubes through a square flue. The tubes extend across between two plates in the flue, the flue being entirely surrounded by water. It will be noted that this arrangement provides ample steam space in these boilers. There was also a drum that encircled the stack which acted as a superheater. The coal consumption of these boilers was about 2 tons per hour.

The present boilers were built for a working pressure of 25 pounds per square inch, and are still working at that pressure, although they are inspected annually. The coal consumption of the present boilers runs about one-half ton per hour. Fig. 13 shows the construction of these boilers. The design, by the way, was approved by the late Rear Admiral George W. Melville, formerly engineer-in-chief United States Navy. These boilers are of special interest owing to the low-pressure for which they were designed, and the thickness of plates, staybolts, etc., in comparison with the practice of to-day. The principal dimensions of these boilers are as follows:

Inside width of furnace...........	3 feet 6 inches
Length of grate....................	6 feet 6 inches
Grate surface, one boiler..........	45.5 square feet
Heating surface, tubes.............	980 square feet
" " flues	100 square feet
" " furnace	91 square feet
" " flue sheets	10 square feet
" " comb'tion chamber.	105 square feet
Total for one boiler................	1,286 square feet

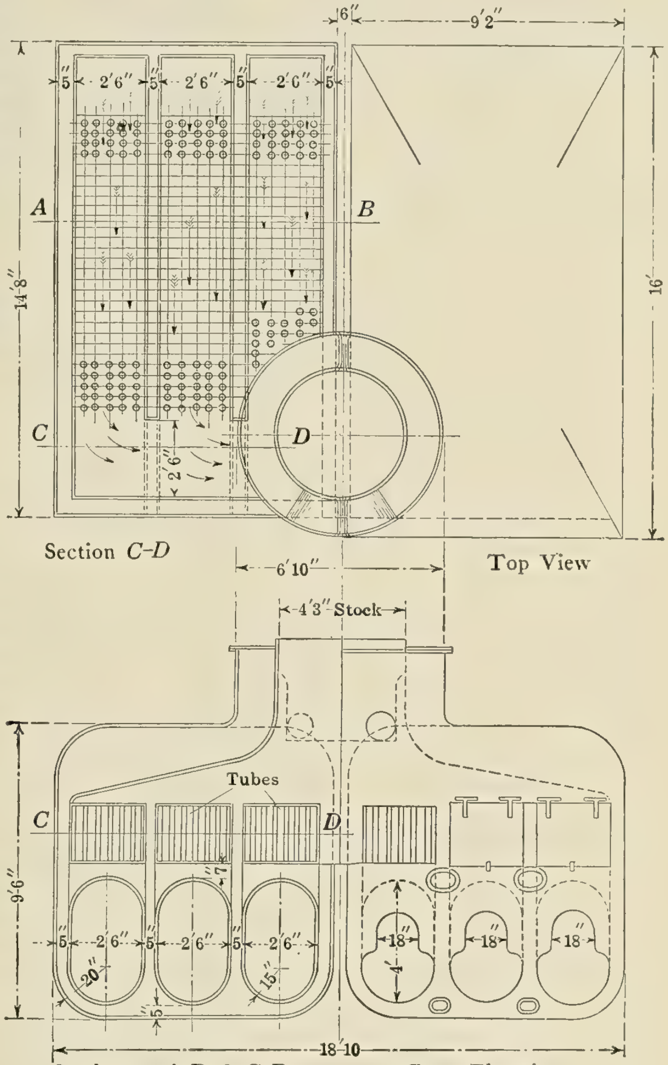


Fig. 12.—The Wolverine's Original Boilers

Ratio of heating surface to grate surface	28.26
Calorimeter	5.93 square feet
Ratio of grate surface to calorimeter	7.69
Number of tubes	78
Boiler pressure	25 pounds

All seams are single riveted except the longitudinal joints of the shell and of the steam drum, which are double riveted.

There is a steam drum built around the stack which serves as a superheater, so it is evident that even in the early days the engineers have given the question of superheated steam serious consideration. It is also evident that this question has been considered to a certain extent when the original boilers for the *Wolverine* were built, as shown by the drum around the stack in Fig. 12.

Superheated steam, of course, is being used to a considerable extent, and to considerable advantage in the navy to-day, although it has its disadvantages. In the case of the *Wolver-*

* Concluded from the December issue.
** Ensign N. F. P., Acting Chief Engineer.
† Formerly Ensign N. F. P. and Chief Engineer.

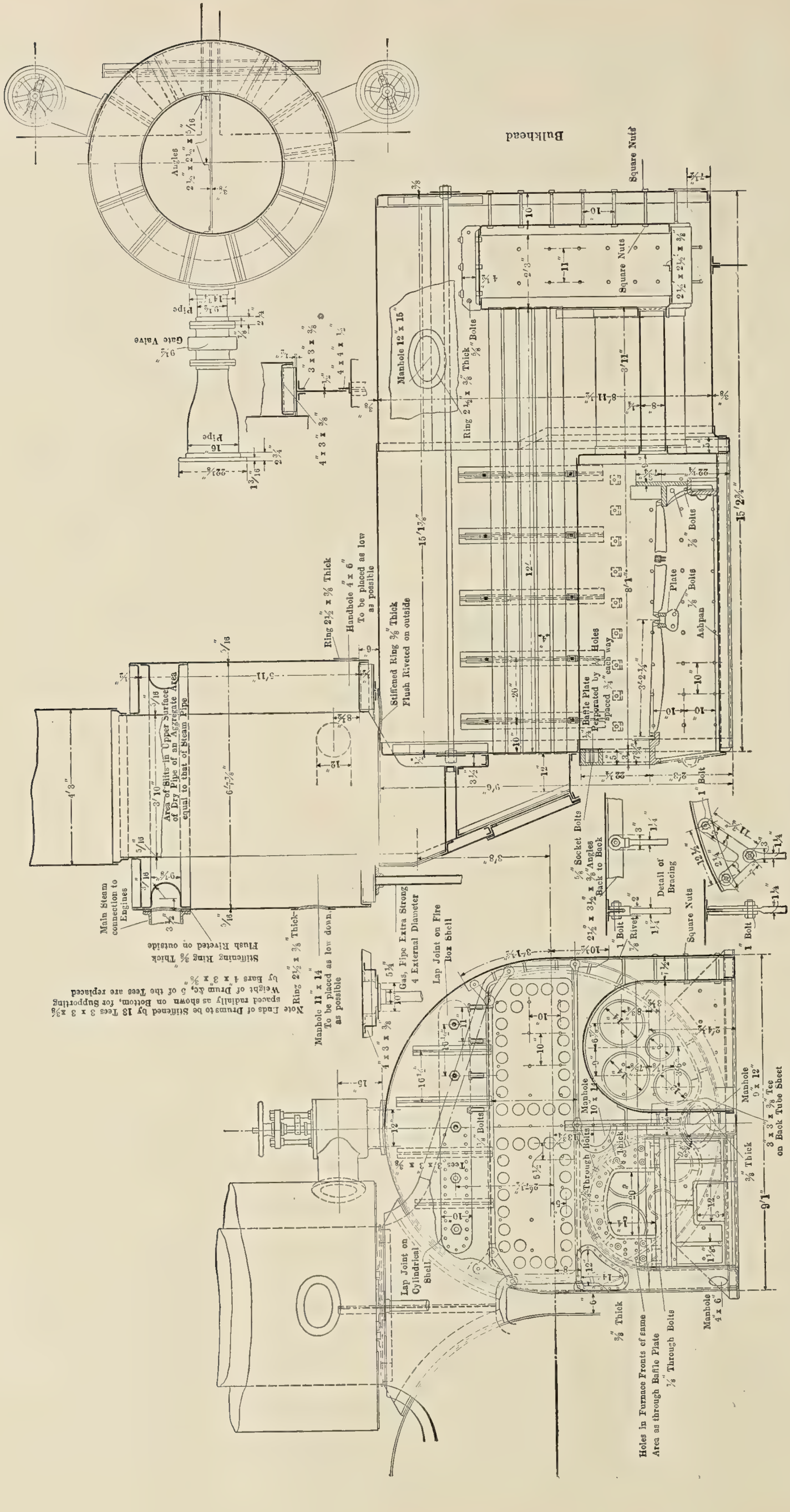


Fig. 13.—Details of Boilers Now Installed on the Wolverine

ine, the steam can be shut off from the drum by the valves shown on the side of it. The valves, as shown on the drawing, have been replaced with a valve that has a side outlet to which a safety valve has been attached. There is also a safety valve on the top part of the drum. All three valves connect to one common copper pipe and discharge into the port wheel-house.

The boilers are set in cast iron saddles, which are bolted to the keelsons. The keelsons, by the way, are the same under the boilers as under the engine; in fact, they continue through the machinery space from bulkhead to bulkhead. In the bilge, under the boilers, about 3 inches of cement has been placed, as the plates showed a little weakness at that point, and it has been found that the cement has decidedly strengthened the plates. The cement has now been in place for several years, and has proved very satisfactory for this purpose.

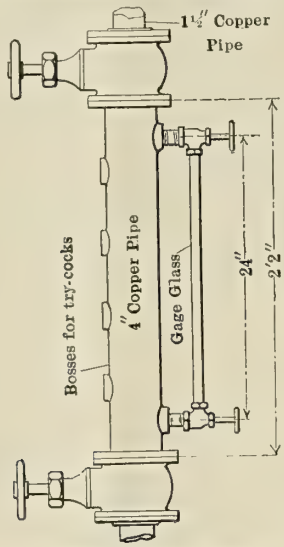


Fig. 14.—Water Column Now in Use

PUMPS AND DECK MACHINERY

The boilers are fed from the air pump when running and by a Doctor pump when not under way. The Doctor pump is the one originally installed when the ship was built, and works very well. This pump, though peculiar in its construction, is yet very simple, and by giving it steam and giving the fly-wheel a twist, it will start up without further ceremony. It is so arranged that you can pump from the sea, bilge, hotwell and tanks to the boilers or overboard. There is also a Blake horizontal double-acting pump, which can be used for the boiler feed, fire main, decks and sanitary system, etc. This pump is also connected to the bilge, hotwell, etc.

Aft of the engine room bulkhead is a large auxiliary hand pump, which is used for pumping from the bilge in case of fire or emergency, and is worked by hand levers on deck. This pump has an 8-inch connection to the bilge. There is a steam winch on the main deck forward for hoisting anchors and other deck gear. It has a small inverted compound engine, which works through a worm and worm shaft. This winch was evidently installed at the time the ship was built.

GENERATOR

Light for the ship is furnished by a small direct-connected generator. There was some difficulty in getting an engine that would run at dynamo speed on this light boiler pressure, but finally, in 1905, a special engine was constructed and placed on board, which furnished a current at 110 volts. For sixty-two years the only lights aboard the *Wolverine* were kerosene (paraffin) lamps and lanterns.

MAIN STEAM PIPE

The main steam pipe is copper, 15 inches diameter, and is attached at the highest part of the steam drum, which is up in the crank room or on the main deck above the engine and fire-room. There is a brass angle valve, with outlet turned down, to which the pipe is bolted. It extends down to the lower engine room and turns aft, and connects to the engine's steam chest through a 15-inch copper tee. Both outlets on the tee, or where they connect to the steam chest, are 15 inches diameter, or of the same size as the main steam pipe from the boilers. The tees also contain the butterfly throttle valves for the main engine.

In handling the engines two men are required, although three would be better, as the two have their hands full. Telegraph signals to engine room have been installed during the last few years. She is also supplied with a revolution counter and oil system worked by the engine, which is original, and also compression grease cups on the main bearings and connecting rods.

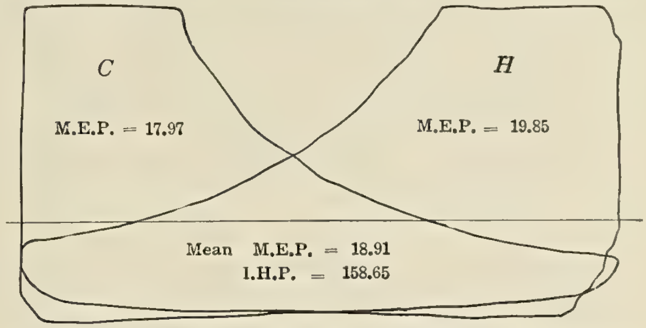


Fig. 15.—Indicator Cards from Starboard Engine. Pressure, 22 Pounds; Vacuum, 27 Inches; R. P. M., 17

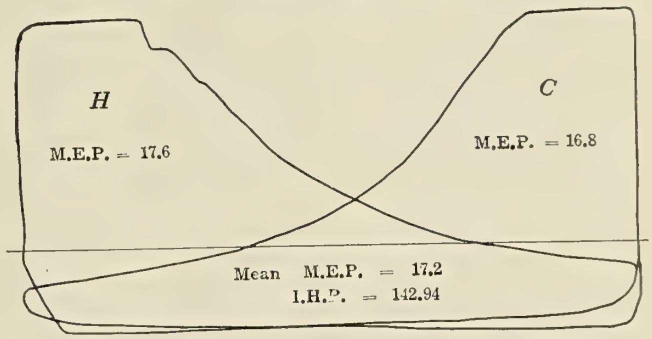


Fig. 16.—Indicator Cards from Port Engine. Pressure, 22 Pounds; Vacuum, 24 Inches; R. P. M., 17

The boilers are so closely fitted in the space it is hard work to give them the necessary attention they should have, especially the accessories on same. The stringers, or gallows frame, continue on to the bulkhead forward of boiler, and it was cut away considerably in order to get the present boiler under them. The check valves and water column and other fittings are rather antiquated, but still serve the purpose well.

GENERAL NOTES

The *Wolverine* is a little too large to permit of her being taken to the ocean, as she will not pass through the locks. She is remarkably steady in a seaway, and takes on but little sea, owing to a very high bulwark and to' gallant forecastle. She is a trifle mean to handle in windy weather about docks, as she doesn't draw much water, and the wind will "kick" her around quickly if the helmsman is not onto the trick.

Former records show that the *Wolverine* never made more than 10 knots' speed in regular service. At the time of the assassination of President McKinley she was in the harbor at Cleveland, Ohio, and upon being ordered to Buffalo, with all possible haste to prevent a riot, the safety valves were weighted, and they were able to get 30 revolutions out of the engines at one time during the trip. This gave her a speed of about 14 knots.

The naval militia was very fortunate in securing this old ship, as she is roomy and well adapted for just the purpose for which she is used, and the citizens of Erie felt they could not part with her owing to the number of years she had been a part of the city, so to speak.

The Ohio militia made some drastic efforts to secure her for their State for the same purpose, but the city and surrounding country got together and formed two divisions, consisting of about 200 men, not including officers, and that was about the necessary allotment that was necessary to keep her in the State of Pennsylvania, and about six to eight months after same had been formed she was turned over to the State of Pennsylvania by the United States Government for training purposes. During the summer months the boys spend their week-ends aboard her, where they have the use of boats and tackle and also have their food.

The object of this article is not to advance any "new ideas" in marine engineering, only to show, if possible, the progress which has been made in the last half century through scientific, theoretical and practical application of principles by comparing the engines of the *Wolverine* to the latest battleship of to-day.

Indicator Cards

The indicator cards shown in Figs. 15-16 are cards taken this year on the *Wolverine's* first trip out after having been laid up all winter. The cards indicate a slight leak in the valves, but this wavy line very often happens to be caused by the valve rebounding after it is first seated and admits a little steam which shows up in the expansion line. The cards give the necessary data. The approximate clearance, as near as it can be arrived at from the cards, seems to be about 5 percent of the piston displacement.

The indicated horsepower, worked out from the cards shown with slide rule, is as follows:

$$\text{Indicated horsepower} = \frac{PLAN}{33{,}000}.$$

Port engine, indicated horsepower

$$= \frac{17.2 \times 8 \times 1017.9 \times 17 \times 2}{33{,}000} = 144.3 \text{ I. H. P.}$$

Starboard engine, indicated horsepower

$$= \frac{18.91 \times 8 \times 1017.9 \times 17 \times 2}{33{,}000} = 158.65 \text{ I. H. P.}$$

Total for both engines $= 144.3 + 158.65 = 302.95$ indicated horsepower.

Where P = mean effective pressure.
L = length of stroke in feet.
A = area of piston.
N = revolutions per minute.

The approximate steam consumption of the engines, calculated from the indicator cards (steam pressure from card), is as follows:

Steam consumption, port engine,

$$= \frac{1.8 \times 2 \times 17 \times 60}{144.3} = 25.44 \text{ pounds per hour per I. H. P.}$$

Steam consumption, starboard engine,

$$= \frac{1.8 \times 2 \times 17 \times 60}{158.65} = 23.15 \text{ pounds per hour per I. H. P.}$$

The above computation gives only the approximate steam consumption on account of leakage of valves and initial condensation of steam in the cylinder. The actual consumption is somewhat greater.

Coal Consumption

The two boilers when carrying 20 to 25 pounds of steam and under way consume about one-half ton of coal per hour, the coal being the best grade of Pocahontas.

The average of 140 pounds per knot brings the evaporation to about 6.17 pounds of water per pound of coal as fired.

A New Method of Stapling

By Edwin B. Wheeler

What is known as water or oil-tight stapling, coming under the head of anglesmith work in shipbuilding, is undoubtedly the most troublesome and expensive member of the structural family which forms the finished hull. I believe it can be safely stated for all practical purposes that anglesmith stapling, bolted in place ready for riveting, costs the American shipbuilders close to 30 cents (1/3) per pound for labor alone. With shipbuilding shapes from which the staples are wrought costing the purchaser about 2½ cents (0/1¾) per pound, something seems to be wrong.

Taking our market price for "shapes"—2½ cents (0/1¾) per pound—into consideration, what does this represent?

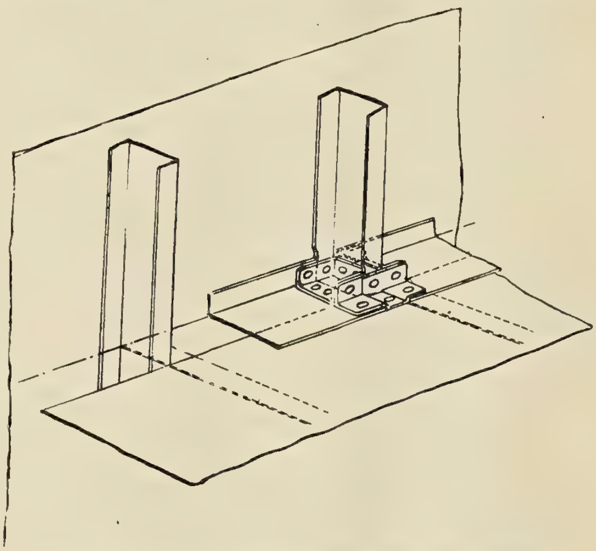


Fig. 1.—Angle Intercostals and Independent Staple

Roughly speaking, it covers the mining of iron ore, numerous handlings, smelting, furnacing, rolling and shaping, to which overhead charges and profit must be added. Something still seems to be wrong, judging from the above comparison.

The shipyard mechanic turns his part of the work out as fast as human hands will allow, and even with care and good workmanship in busy shipyards a considerable percentage of stapling work is scrapped each year, due mostly to cracked welds after bolting up or riveting. It appears that the above mechanic is asked to perform an impossible task in building the anglesmith stapling in common use for figures approaching the cost of other structural parts.

There is no doubt that in certain locations on ships, and in some designs of vessels, the anglesmith staple is a necessary evil, but of late years, especially, our largest and most important vessels, the battleships, for instance, have grown larger and larger, requiring more bulkheads, both longitudinal and transverse, as well as decks and watertight flats, necessitating increased amounts of water or oil-tight stapling work. About 75 percent of this stapling is dead flat, or nearly so, and can be constructed without anglesmith labor and with very little assistance from the shipfitters, whose combined efforts cost the shipyard the bulk of 30 cents per pound, above referred to.

The accompanying sketches give the principle upon which this 75 percent of stapling could be constructed in a more economical and far less complicated manner. Other dead flat work is not furnaced, twisted, welded and then brought back to its original section before placing in the ship, at least not in the shipyard, for one of the main ideas of good modern designing is to so shape the construction of a vessel that the minimum of furnace work is allowed to creep in, so why treat the bounding bar to all of this unnecessary attention that is so expensive?

It will be noted that this design of construction allows the employment of a universal system, and therefore could be turned out along with decks and bulkheads to take its place directly upon the erection of structural parts. This point alone is of inestimable value, as with the stapling in general use all structure in the neighborhood of joints to be collared must be in place and trued up before work on the bounding bars can be

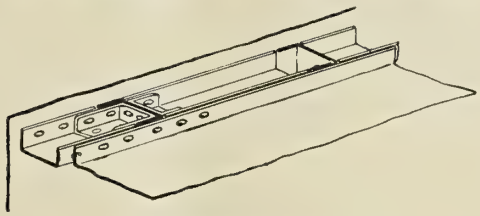


Fig. 2.—Channel Intercostals

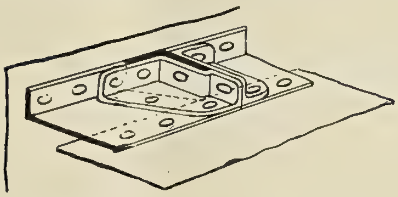


Fig. 3.—In Way of Angle Bar

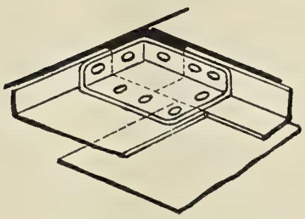


Fig. 4.—At Bulkhead Corner

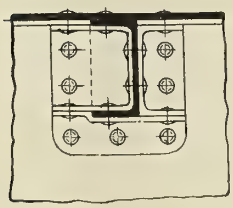


Fig. 5.—With Flanged Deck or Bulkhead Plating

commenced, causing delay in testing of compartments and in the final delivery of the ship as well.

Touching upon the practical points of the universal staple, the intercostal shape should be cut a trifle longer than the space it is intended to fill. This is to allow for the come-and-go of the frames from their original stations, the toe of frame, beam or stiffeners to be chipped away where found necessary. The flanged boxes and face clip offer simple pressing operations in their forming, and would surely not cost more than a small fraction of the stapling now commonly employed.

Just how far the independent staple and intercostal plate construction could be carried into beveled work before it would approach the cost of anglesmith stapling, only actual working conditions can tell. One thing strongly in favor of its use, however, away from the dead flat, is that though new dies would be needed to press beveled boxes, they could be called new for only the first ship or two, as the same bevels occur over and over again on all ships, though possibly at different stations. The same rule will hold good should the collars be made from cast steel, as in this case the original pattern takes the place of the die, and so far as different shapes or sections to be stapled go, there are but a few in general use, and they are all adaptable to this method, which offers undeniable advantages for dead flat or slightly beveled work, and is bound to bring the cost of this detail of ship construction into closer comparative relations with other members of the structural family.

Structure of Vessels as Affected by Demand for Increased Safety*

BY WILLIAM GATEWOOD

In view of the general interest which has been taken recently in the subject of safety of travel by water, culminating in an International Conference on Safety at Sea, it was thought that a short paper in the Transactions of this Society touching on some of the problems involved would not be amiss.

The dangers of the sea in times past were so great that a safe return from a voyage was a subject of public thanksgiving. It is still so considered by many; but the progress in the arts of shipbuilding and navigation, and the safeguards provided in the way of lighthouses, etc., have rendered travel by water actually safer than travel by land.

There is, however, at the present time a demand for greater safety, and this demand for increased safety is natural, and is the indirect result of the advance in civilization. Human life was never considered so precious as at the present time. Look at the prominence now given to the prevention of disease, and compare it with conditions which prevailed a century or two ago. Look at the Peace Conferences and Disarmament Plans, at the Employers' Liability Laws, and even at the courts, which are loath to condemn even murderers to death unless they are hardened criminals.

The natural tendency of the general public after any calamity involving great loss of life is to forget that absolute safety is impossible of attainment, and that the progress on which we pride ourselves cannot be made if the handicap is imposed that no risk of any kind shall be taken. The precautions which should be taken in any undertaking depend in great measure upon the disadvantages which are incurred concurrently with the precautions taken. For instance, if to insure the saving of one-half of the loss of life which occurs annually on our railroads it were necessary that all passenger and freight trains should run at half speed, the public would not stand for the change, as the effect on the business and private life of the country would be considered intolerable.

Further precautions in connection with the safety of vessels would seem advisable then only where they do not interfere so seriously with the present methods of conducting business and pursuing pleasure as to be considered a detriment to progress. The unsinkable vessel must be commercial or it will find no place in the merchant marine of this or any other country. The problem that is presented at the present time is, therefore, to build vessels which shall be as safe as it is possible to make them, consistent with the requirements of their trade. In other words, if further precautions in the building, navigation and upkeep of vessels for the purpose of promoting safety

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

are to be taken, they should be along such lines and so limited in extent that the commercial success of the vessels is not jeopardized. As the safety of vessels is a matter which is not apparent to the general public, it seems proper that it should be made the subject of national or international regulations as far as regulations can conduce to increased safety.

The dangers against which precautions should be taken in connection with the structure of a steel vessel may be classified as follows: Leaks, storms, ice, grounding, collision and fire.

Leaks

Intact outside plating to above the water surface is such a common feature of new steel vessels that no comment on this subject is needed, except, perhaps, that the Government should require that the outside plating of old vessels should be subject to examination at intervals and should be kept up to a certain standard of strength and tightness, and that underwater openings should be properly protected.

Storms

The precautions against storms should include the elements of strength, watertightness, stability and control.

Strength.—The rules of the classification societies are based partly on experience and partly on theory, and in general may be said to provide ample strength of structure. Indeed, there are many instances of vessels in service which have scantlings much below the standard of the classification societies, and which have shown no signs of weakness. It is generally accepted that if this matter is covered by legislation in this country a suitable method would be the assignment to every vessel of a maximum load line, which should be determined from a consideration of the scantlings of the vessel and her route in service. It is suggested that this maximum load line could be lowered as the age of the vessel increases, in a similar manner to the reduction of pressure on a boiler, to allow for deterioration. The stresses in the structure of a vessel seem to increase rapidly with increase of draft and displacement, and although the amount of the stress would depend on the shape of the vessel and the distribution of the cargo and other weights, it is considered that no fairer method of obtaining the measure of precaution as regards strength of structure to weather storms can be devised than by what is known as the assignment of freeboard.

To illustrate the effect of increase in draft the case is presented of an oil tanker, 389 feet by 49¾ feet by 30 feet. When loaded to a draft of 20 feet, displacement 8,720 tons, the compressive stress in the upper deck figures out at 6½ tons per square inch in hollow of wave 385 feet by 19¼ feet. When loaded to a draft of 24 feet 3 inches, displacement 10,705 tons, the corresponding stress increases to 9⅛ tons per square inch, or an increase in stress of 40 percent for an increase in draft of 21 percent.

Freeboard must also be considered in connection with stability and in case of damage.

Watertightness.—Under this heading would come not only the tightness of the underwater plating, but also the tightness of the plating above water, of the decks and erections, and of the openings in the sides, decks and erections. No special precautions in addition to those usually taken would seem necessary except the prohibition of the use, while under way, of openings which would be submerged in damaged condition.

Stability.—This is affected so greatly by stowage of cargo, etc., that a vessel which has a large measure of initial stability leaving port may have no margin of initial stability at the end of the voyage. Indeed, the introduction of water ballast is not an uncommon expedient adopted on many vessels to compensate for the fuel used. Some very successful vessels are unstable when light, and have ample stability when loaded. To provide for a proper amount of stability by legal enactment would seem almost impossible, especially if possible damage is considered.

As illustrating the difficulty of making any regulations regarding the stability, there is instanced the case of a passenger steamer which, while light, was sunk in shoal water as the result of a collision. The openings were patched and the vessel was ready for pumping out, when the question arose as to what was likely to happen during the process. Curves plotted for the ship "without ballast" show that the vessel would have been stable when first afloat at 30-foot draft, but would have become unstable as more water was pumped out and the draft was reduced to 18 feet or less. It was decided, therefore, to put ballast on board, as low in the vessel as possible—some 476 tons were added—and the corresponding curves "with ballast" indicate that under such conditions there was no lack of initial stability at any intermediate draft. That the vessel would have so large a measure of initial stability in this condition, with the holds and machinery spaces flooded, was hardly to be expected. Some photographs were taken of the vessel just after the collision, and the large list at one stage of sinking indicates that without ballast the lack of stability was far from being imaginary.

Control.—Suitable steering gear is so necessary that considerable attention is given to the subject in the design of all vessels. While accidents due to lack of control are frequent, it is doubtful whether anything would be gained by any departures from the recognized appliances.

Cases of loss of control of a vessel by derangement of the machinery are not infrequent, but are so much less frequent than formerly that this particular advantage claimed in former years for twin screws is nowadays not much discussed.

Ice

Special provision is made in the structure of vessels which are expected to run through ice by means of special framing and plating forward near the water line. Contact with icebergs is a special case of collision, or, as in the case of the *Titanic*, it may be described as a case of side grounding.

Grounding

This is one of the most common dangers from which vessels suffer. In many cases, when the ground is soft, no serious damage is done. But it does not seem feasible to design a vessel so that the bottom plating shall not be punctured or the stern frame broken when the conditions are not so favorable. The amount of leakage into the vessel can be reduced by subdivision into watertight compartments, and the problem which is presented is how best to effect sufficient subdivision without too much cost and without interfering with the service of the vessel. The fitting of an inner bottom for the purpose of storing water for feed or ballast and recently for the stowage of oil fuel, serves as the most desirable type of subdivision. As bottom damage often extends to the bilge beyond the limits of the standard double bottom, the extension of the double bottom to the upper turn of bilge, now not infrequent, affords an additional safeguard. But while accidents due to grounding often cause the loss of vessels and of their cargo, in remarkably few cases would loss of life seem to be involved.

Collision

This source of danger is probably the cause of the majority of fatalities incident to travel by water, and means for minimizing the effect of collision are being given careful consideration by the maritime world, as the result of the loss of the *Titanic*. Collisions occur in so many different ways that it is difficult to decide what precautions will be effective in every case. Until the collision of the *Titanic* with an iceberg it was generally considered that if a vessel would not founder with any two compartments open to the sea, that vessel would be extremely safe. The number of vessels of which so much can be truly stated is very small.

The safety of cargo vessels does not need Governmental regulation, except only in so far as the safety of the crew is concerned, as all questions relative to the safety of the cargo will be settled by the shipowners and underwriters to suit the demands of trade. It is probably true that the precautions which should be taken for the safety of the crew do not need to be as great as for the safety of passengers, for reasons which are chiefly economic. The advantages of not handicapping trade are so great that the taking of risks by the people engaged in any trade is accepted. In all building operations there is a loss of life for every sum of money spent, and while this is to be regretted, there does not seem any remedy which will prevent accidents entirely, except a complete cessation of work—and that is no remedy. The precautions which should be taken must be such as will not handicap the business unduly—and what is considered proper to-day in the present state of the arts and of public opinion may hardly seem sufficient a few years hence. The advancement which has been made in ocean navigation in one century shows that many of the risks of the former days have vanished. The increase in the number of lives involved in any one accident is the real reason why, at the present time, additional precautions are considered necessary.

It is suggested, therefore, that the basis for further precautions in the structure of vessels should be the number of lives involved; and further, that greater precautions should be taken for the lives of passengers than for the lives of an equal number of the crew.

Protection of the propelling machinery, which prevents loss of control of the vessel, would seem to be of next importance to protection from foundering. Double bottoms under machinery spaces to afford protection in case of grounding, and on vessels carrying a large number of passengers wing compartments to afford protection in case of collision would seem in order.

Protection from foundering in case of collision would seem to be obtained in proportion, as a greater or less length of a vessel's side could be open to the sea without endangering the buoyancy or stability. Double bottoms would be of little use for this purpose. Watertight decks near the waterline in intact condition would seem of no great benefit, as the damage would as like as not extend both above and below this deck; and, in most cases, they would seriously interfere with handling cargo. A fore and aft bulkhead at the center line would help to preserve the buoyancy, but would probably destroy the stability. Wing bulkheads spaced far enough from the side to be safe from injury by collision would be prohibitive in handling ordinary cargoes, and could be adopted with advantage in special cases only. Subdivision by transverse bulkheads is, therefore, the logical precaution to take. It is structurally simple, and transverse bulkheads interfere very little, if at all, with the handling of any kind of cargo, provided they are considered in the design of the handling appliances. Even lumber vessels can be built with numerous transverse bulkheads.

If it is determined that a vessel carrying a certain number of passengers and crew shall be safe from foundering with a certain proportion of the length of the side open to the sea, and it is attempted to obtain this result by transverse subdivision, diagrams may be prepared which will give an idea of the conditions which will exist as calculated for a hurricane deck coastwise passenger vessel. The vessel considered is 370 feet long from stem to propeller post, 49 feet 6 inches beam and 35 feet deep to hurricane deck. The collision bulkhead is located at 6 percent of the length of the vessel abaft the stem and the forward bulkhead of the machinery space is 46 percent of the length abaft the stem. There are six transverse bulkheads in all. The vessel was assumed under two conditions of loading, one to give a draft of 18 feet 6 inches and the other to give a draft of 24 feet.

The conditions as to draft and initial stability were first determined with the fifth part of the length of the vessel abaft the collision bulkhead open to the sea, considering the void spaces in the hold as 50 percent. For each condition of loading the freeboard at the collision bulkhead must exceed 25 percent of the draft, and the after bulkhead of the flooded compartment must extend above the load line, more than 18 percent of the draft.

With the fifth part of the vessel's length forward of the machinery space open to the sea, the height of the forward bulkhead of the compartment must exceed 19 percent of the draft, and the height of the forward bulkhead of the machinery space must exceed 13 percent of the draft above the load line.

With two-fifths part of the length of the vessel abaft the collision bulkhead open to the sea, the freeboard at the collision bulkhead must exceed 65 percent of the draft, and the forward machinery bulkhead must extend not less than 30 percent of the draft above the load line.

Initial stability seems satisfactory in all the conditions considered, but it must be remembered that the void spaces in the vessel are assumed to constitute 50 percent of the total, and this assumption will not be correct for vessels when carrying a small amount of cargo, or where the cargo is of great density, such as steel, iron ore, etc.

On this vessel, therefore, under the assumed conditions, transverse bulkheads spaced as shown, and extending to the deck below the hurricane deck, would afford protection in case of collision opening any one compartment to the sea, with draft intact not exceeding about 23 feet. They would also afford protection in case any two compartments were open to the sea, with draft intact not exceeding about 18½ feet. To afford protection at greater drafts, the bulkheads, with spacing shown, must extend to the hurricane deck, and the limit of draft would seem to be about 24 feet in case of damage bilging two compartments.

If the bulkheads are spaced closer, dividing the forward hold, for instance, into three compartments instead of two, better protection will be afforded in cases of ordinary collision and of grounding; and three compartments could be flooded with the same degree of danger as is attended by the flooding of two, with the wider subdivision. Or, if it is considered that the damage will not be likely to affect but two compartments, of length about 50 feet each, a greater load draft could be allowed for bulkheads extending the same distance above the keel. The interference with cargo handling and stowing would be appreciable, but not prohibitive.

If more than two-fifths of the length of a vessel is required to be flooded with safety, it would seem that the transverse bulkheads would need to be supplemented, so as to divide the vessel into cells, and this would be commercial in special cases only, as mentioned above. In the case of the *Titanic*, about 30 percent of the length of the vessel abaft the collision bulkhead was damaged, or 36 percent in all.

Fire

While accidents by fire are more frequent on vessels at dock than while under way, it would seem that further precautions could be taken to prevent the starting and spread of fires than are taken on the average vessel. Completely inclosing the freight spaces by steel, including steel covers for hatches and ventilators, would seem proper on vessels carrying any considerable number of passengers. The elimination of a large quantity of wood and other combustible material from passenger quarters can be made in many vessels at small first cost, and in some vessels at a saving in cost. The traveling public, which approves of steel railroad coaches, will probably offer no objection to greater simplicity on vessels if it is accompanied by an assurance of increased safety.

City of Annapolis and City of Richmond

Description of Hull and Machinery of New Steamship Built by the Maryland Steel Company for Service Between Baltimore and Richmond

The *City of Annapolis* and *City of Richmond* are two new steamships recently completed by the Maryland Steel Company for the Chesapeake Steamship Company for service on the Baltimore and Richmond route.

That the management of the Chesapeake Steamship Company is alive to the interests of its patrons is being demonstrated by the service it affords. These new steamers are classed among the finest and most modern that run out of Baltimore; they combine all the comfort, convenience and luxury that the traveling public now demands, and the manner in which the Maryland Steel Company, under the direction of Mr. Key Compton, president of the Chesapeake Steamship Company, has fitted up these vessels speaks for the same popularity with the traveling public that the Baltimore & Norfolk Line has enjoyed since its earlier steamers, the *City of Baltimore* and *City of Norfolk,* were put in service.

The general dimensions are as follows:

Length over all....................	277 feet
Length between perpendiculars.....	267 feet
Beam, molded on waterline........	43 feet
Beam, molded over guards........	53 feet
Depth, molded to main deck........	16 feet 5 inches
Draft, loaded	12 feet 6 inches

These vessels are built on the Isherwood system of longitudinal construction, and are classed by Lloyd's A-1 for twenty years for bay service.

Hull

The hull is constructed of mild open-hearth steel, with flat plate keel, bilge keels, lower and main decks. The main deck is plated all fore and aft, with a wood deck over. The stem, stern post and rudder are of the best hammered scrap iron. There are seven bulkheads, of which five are watertight.

The general finish is old ivory throughout the saloons, passengers' dining saloon, smoking room and lobby. The lobby on the main deck aft is finished in selected mahogany, as are all main stairways. Ornamental metal balustrades are fitted on all stairways and around the wells. The ladies' saloon aft, on the main deck is finished in sycamore. The president's room is on the gallery deck, and is paneled in old ivory. The captain's quarters consist of office, bedroom and private bath, and are finished in quartered oak. The other officers and the crew have quarters on the hurricane deck, aft of the captain's suite, and the finish throughout is cypress, finished natural. The officers' and crew's mess room, pantry, bathroom and showers are also on this deck. A private stairway leads from this deck to the main deck for the use of the crew and stewards. Over the well in the after saloon is fitted a large skylight with ornamental ceiling, and over the main stairway aft is a large dome skylight fitted with a sash of polychrome leaded glass. Opening off the smoking room on the gallery deck are the wireless room, a barber shop and a commodious bar. The chief engineer and assistant engineers have large rooms on the main deck aft of the freight space and alongside the smoking room.

There are four staterooms with two berths and showers; ninety staterooms having two metal berths; seven bedrooms with brass beds, five of which have showers; nine bedrooms with brass beds and private baths communicating; seven staterooms with two metal berths and private bath communicating, making a total of 117 staterooms. All staterooms are fitted with independent heat and running water. The outboard staterooms and bedrooms are fitted with inter-communicating telephones and the inside rooms with return call bells. Telephones are also fitted in the president's room, purser's office, bar, wireless room, dining rooms, captain's room, chief engineer's room and engine room. The spaces on the lower deck forward and aft are divided into quarters for first and second class men and women; aft on main deck is a ladies' cabin.

The pilot house is large and roomy, and is finished in oak, and has all necessary mechanical telegraphs and speaking tubes to the engine room, also McNab and running light indicators.

The floors of the dining saloon, lobby, smoking room, toilets and treads of all stairs are covered with interlocking rubber tiling. The saloons are carpeted, and all staterooms except those with showers are carpeted. The bedrooms with showers are fitted with hardwood floors and rugs.

The vessels are fitted with a steam windlass, steam steering engines and steam elevator engines. In addition to the steam steering gear there is an auxiliary hand gear located on the saloon deck aft.

Turbine-driven generators supply the current for lighting the vessels.

The baths and showers are fitted for both hot and cold fresh and salt water, the water being heated by a steam heater in the engine room.

Machinery

The main engine is of the four-cylinder, triple-expansion, surface-condensing type, having cylinders 23 inches, 38 inches and two 45 inches diameter by 36 inches stroke. The cylinders are arranged with one low-pressure at the forward end and one low-pressure at the after end of the engine. They are supported at the front by round wrought steel columns and at the back by cast iron "Y" columns. The back columns are fitted with crosshead guides of the hollow bar type. The connecting rods have brass boxes at the top and bottom with gib and key connections.

The crankshaft is of the built-up type in two pieces. The bedplate is of cast iron, having four short and two long main bearings. The bearings consist of two brass boxes held in place by wrought steel binders and steel bolts. The valve gear is of the Stephenson link type, with a steam ram reverse engine located at the back of the main engine. A one-cylinder steam turning engine is located on the after side of the after low-pressure back column, and operates through worm and gearing on the crankshaft. A main air pump, 22 inches diameter by 13 inches stroke, and two bilge pumps, each 5 inches diameter by 13 inches stroke, are driven by levers and links from the after low-pressure crosshead.

As these boats operate on a night schedule it is essential that the engine be as nearly balanced as possible. This was done by a system of equalizing the moving weights. In regular service it was found that the engines were remarkably quiet. The *City of Richmond* was also tried at the builders' dock with the wheel removed and the engine ran at its normal service revolutions per minute, at which speed there were no perceptible vibrations.

The propeller is of the built-up type, having a cast iron hub and four manganese bronze blades. It is 11 feet 6 inches diameter by 16 feet 3 inches pitch.

Steam is generated by four single-end Scotch type boilers each 12 feet 10 inches diameter by 10 feet 10 inches long, containing three, 41 inches inside diameter, corrugated furnaces. The boilers are built to meet the requirements of the United States Steamboat and Lloyd's inspection rules for 190 pounds

Fig. 1.—Bay Steamer City of Annapolis

working pressure, the total heating surface being 6,845 square feet and the total grate surface 225.5 square feet. A donkey boiler of the return tubular, dry-back type, 7 feet 3 inches diameter by 6 feet long, built for 190 pounds working pressure, is located on the main deck in a casing.

The main condenser is independent of the main engine framing, and is located at the back of the engine; it contains 3,810 square feet of cooling surface. The following auxiliaries are fitted:

A multi-coil feed water heater, two 25-kilowatt turbine-driven electric sets, one 5-kilowatt engine-driven electric set, two vertical simplex 10-inch, 6-inch, 24-inch feed pumps, one horizontal duplex 6-inch, 5¾-inch, 6-inch condenser drain pump, one vertical duplex 12-inch, 7-inch, 12-inch fire and donkey pump, one horizontal duplex 6-inch, 7½-inch, 6-inch sanitary pump, one horizontal duplex 5¼-inch, 4¾-inch, 5-inch fresh water pump, one centrifugal circulating pump with 12-inch nozzles, driven by a vertical single-cylinder 9-inch by 9-inch steam engine, one horizontal duplex 4½-inch, 3¾-inch, 4-inch mate's pump located forward, two horizontal duplex 3-inch, 2-inch, 3-inch hot water pumps and an ash ejector in the fire-room.

The character of the piping is first-class throughout, the main and auxiliary steam lines being of steel and all outboard piping of copper, not less than ¼ inch thick.

NATIONAL MOTOR BOAT SHOWS.—Two important motor boat shows will be held this year by the National Association of Engine and Boat Manufacturers. The first is the tenth annual National Motor Boat Show, which will be opened in Madison Square Garden, New York City, Jan. 31, closing Feb. 7. The second is the first annual Chicago National Motor Boat Show, which will be held at the Coliseum, Chicago, Ill., Feb. 28 to March 7. More boats of diversified types will be shown this year than ever before and special interest will be attracted by the exhibits of heavy oil engines, several of which of American build will be shown. These motor boat shows merit the hearty support of all engine and boat manufacturers.

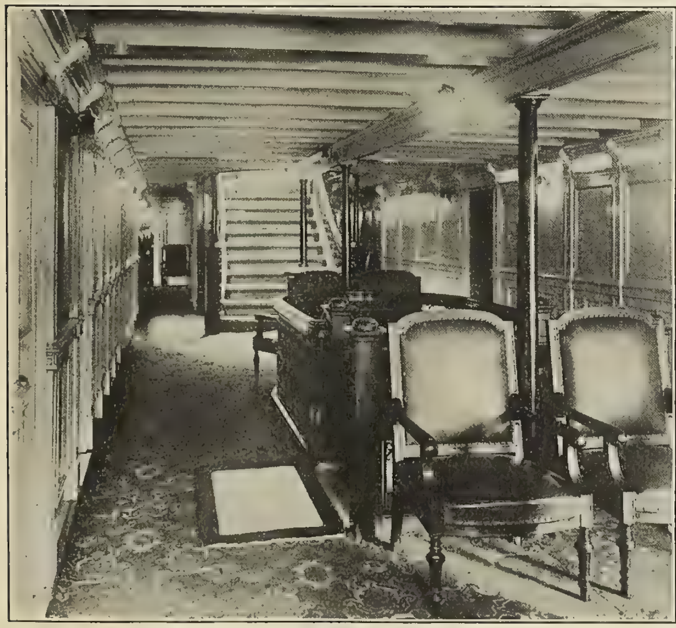


Fig. 2.—Social Hall

Fig. 3.—Stateroom

American-Built Chinese Cruiser Fei Hung

Chinese Training Ship Constructed by the New York Shipbuilding Company—General Description of the Vessel and Trial Data

The *Fei Hung* is a light cruiser, built for the Chinese navy for use primarily as a training ship, although she is also available for all the war functions that can be expected from a vessel of this size and class. She is a deck-protected cruiser, driven by turbine machinery and carries an armament fully up to the standard of her class.

Constructed by the New York Shipbuilding Company, of Camden, N. J., from outline requirements supplied by the Chinese Government, she is of the same class as the *Ying Swei* and *Chao Ho,* recently completed in England. Some latitude was allowed the builders, so that all the boats have minor differences in arrangement and motive power. What follows relates only to the *Fei Hung* unless specially noted.

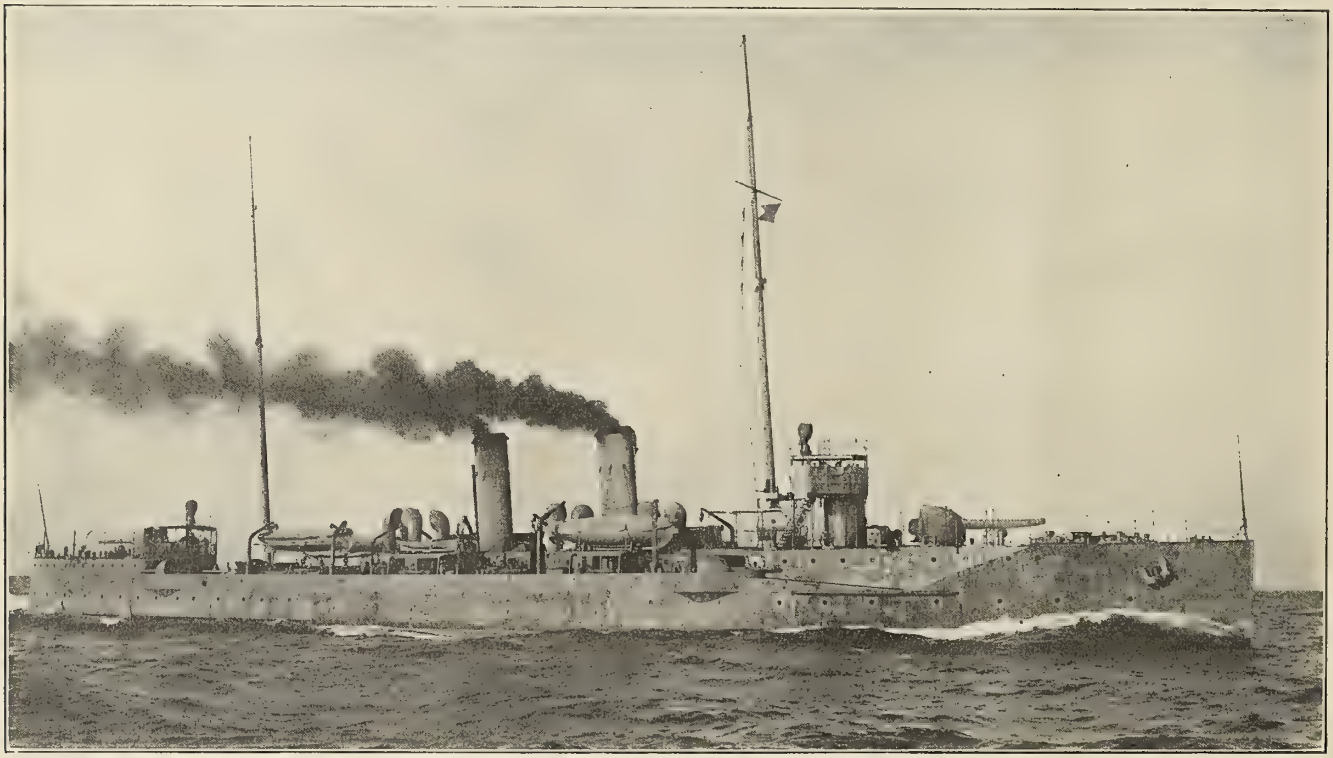


Fig. 1.—The Fei Hung on a Trial Run; Speed 20.536 Knots

The outline data and general description of the hull is as follows:

Length over all	322 feet
Length between perpendiculars	320 feet
Beam, molded	39 feet
Depth, molded	22 feet
Normal displacement	2,600 tons
Normal draft	14 feet
Freeboard, forward	18 feet 3 inches
Normal complement	230
Bunker capacity (coal)	600 tons
Bunker capacity (oil fuel)	100 tons
Full forecastle length	87 feet
Full poop length	58 feet
Double bottom, under machinery	117 feet

Fig. 1 shows the general appearance of the vessel; the officers are berthed in sixteen staterooms forward, in the forecastle and on deck; the crew are in large compartments on the berth deck and in the poop. A large sick bay is fitted in the poop. The galleys are on deck amidships. The magazines are located on a platform deck, both forward and aft, with storerooms, etc., below in the holds, thus ensuring a maximum of protection.

The oil fuel is carried in tanks at each end of the machinery spaces. Trimming tanks, fresh water and reserve feed tanks are all provided.

Cold storage compartments are fitted on the protective deck abreast the engine hatch. Stowage for torpedoes is provided below deck. The weather decks are wood sheathed. Under the bridge an armored conning tower and communication tube are fitted.

A very complete outfit of boats is provided, including one steam launch and one motor whaleboat; there are eight rafts and boats in all.

Armament

The vessel is armed as follows:

Two 6-inch guns, 50 calibres, with shields.
Four 4-inch guns, 50 calibres, with shields.
Two 3-inch guns.
Six 3-pounders.
Two 37-milimeter automatics.
Two 18-inch deck torpedo tubes.
Small arms for crew.

The 6-inch guns are located one on the forecastle and one on the poop; the 4-inch guns are on the main deck at the breaks of poop and forecastle; the 3-inch, 3-pounders and torpedo tubes are arranged along the waist, and the automatics on the forecastle deck under the bridge. All this armament, including the first supply of ammunition, was supplied by

Sir W. G. Armstrong, Whitworth & Company, Ltd., in order that the armament of all the ships should be of similar make, using the same ammunition. The automatics are by Vickers, Ltd.

The gun trials were successful in every respect; several rounds per gun were fired with full charges, at varying degrees of train, followed by a broadside; this trial was carried out in connection with the speed trials. Armored hoists electrically operated, are fitted to each 6-inch gun, the other guns being served by hand whips. The torpedoes are stowed in boxes on deck and below in a special space.

PROPELLING MACHINERY

This vessel is fitted with an installation of Parsons turbines of the regular standard all-reaction type and design, which has proved so successful in vessels of this type. The machinery is arranged in one engine room, and there are three lines of shafting, with one propeller on each shaft.

The high-pressure ahead turbine drives the center shaft, and has fifty-six rows of blades in the casing and a similar number on the rotor, while the diameter of the rotor is 39 inches. At the forward end of this turbine a cruising element is arranged, which has an additional sixteen rows of blades in the casing and rotor respectively. This stage helps to improve the economy of the turbines at cruising speeds.

A combined low-pressure ahead and astern turbine drives each wing shaft, the low-pressure ahead turbines having sixty-four rows of blades in the casing and rotor respectively, with a drum diameter of 55 inches. Each astern turbine has forty rows of blades in the casing and rotor respectively, the drum diameter being 44 inches.

The turbine bearings are supplied with oil under pressure, while the line shaft bearings are lubricated on a ring system.

The turbine machinery worked most satisfactorily throughout all the trials, and the turbine bearing journals retained a constant temperature at all times. Heavy weather was experienced during the runs, with excessive rolling of the ship, but this did not appear to affect the steady running of the turbines in any way.

Dummy readings were taken regularly throughout the runs, and showed that the rotors were floating under nearly all running conditions, with consequently very light loads on the turbine adjusting blocks.

Auxiliary exhaust connections are arranged at different stages throughout the turbines, so that full use can be made of any available exhaust steam which the feed heater does not use and would otherwise be discharged directly into the condensers.

The boilers are of the Thornycroft express type, three in number, located in two boiler rooms, one in the forward room and two in the after room, all on the center line of the ship, flanked by the coal bunkers and with a cross bunker leading to each boiler for use in action. The total heating surface is 14,493 square feet and the grate surface 270.75 square feet. The working pressure is 240 pounds per square inch. The forward boiler is fitted with an auxiliary oil fuel plant, worked on the mechanical spray pressure system. The stokehold is closed and air forced in by means of blowers, one to each boiler.

The propellers are three in number, the wing screws turning outboard; the diameter is 66 inches and the pitch 62 inches; each having three blades.

The vessel is fitted with all the auxiliaries usually found in a cruiser of this type, such as mechanical ventilation, steam heating, cold storage plant, pumping, flooding and drainage systems; air compressors, electric lighting, steam steering gear, steam windlass and electric winches. Complete wireless, signaling and communication systems are installed.

The engines and the boilers were built by the New York Shipbuilding Company and the auxiliaries by standard manufacturers of the various types.

TRIALS

The results of the trials may be summarized as follows:

Item	Standardization, Mean of High Runs	Four-Hour Full Speed	24 Hours at 18 Knots
Displacement	2,600	2,600	2,600
Speed in knots	21.00	20.3	18.5
Revolutions per minute	560	535	478
Shaft horsepower	8,640	7,490	5,000

These trials were run in October last outside the Delaware Capes, the measured mile off the Breakwater being used for the standardization.

Annual Report of the Chief of the Bureau of Steam Engineering

MACHINERY OF THE FLEET

The upkeep of the machinery of the fleet is always a matter of first consideration, and in a fleet whose machinery aggregates nearly 2,000,000 horsepower it is to be expected that at one time or another some of the vessels will be out of service on account of defects or derangement of machinery, but it is gratifying to be able to report that the machinery of the fleet as a whole in excellent condition and that this applies to the vessels of both the active and the reserve fleets. The maintenance of the machinery of this fleet in such good condition is due in no small measure to the stimulus of engineering competition, to the practice of having regular overhaul periods for ships, and to the economical and efficient work done in the machinery division of the navy yards, without which it would not have been possible to keep the machinery of such a large fleet in good condition on an appropriation actually less than was available for a fleet of little more than one-half the power five years ago.

The turbine reduction-gear machinery of the *Neptune* has been continued in service while waiting for the completion of a new set which the contractors will install. The reduction gear has proven quite satisfactory.

The *Yorktown* has completed a general overhauling, including the installation of new boilers, and new boilers have been installed in several tugs and colliers. The usual retubing of boilers and condensers has been carried out, and considerable work has been done in the manufacture of propellers and propeller blades.

A number of alterations have been made tending to improve the machinery of vessels of the fleet, the most important being the installation of turbine driven blowers to replace old ones driven by wornout reciprocating engines, and improvements in the method of introducing boiler feed water.

The work of converting the *Vestal* into a repair ship is practically completed, and similar work on the *Prometheus* is well under way.

DESIGN OF MACHINERY

Plans and specifications were prepared for the machinery of the battleships *Pennsylvania* and No. 39, for torpedo destroyers Nos. 51 to 56, inclusive, for the destroyer tender *Melville*, and the submarine tender *Bushnell*, contracts for which have been awarded. Plans were also prepared for the machinery of the collier *Kanawha*, building at Mare Island.

Contract has been entered into for plans for the heavy oil engines of the *Maumee*, a sister ship of the *Kanawha*, and it is expected that the work of constructing these engines will soon begin at the New York Navy Yard. These engines will be built under the special authorization given in the last naval appropriation bill, and their construction and installation should contribute greatly to our knowledge of this type of engine and its possibilities for use for the large power required in battleships.

The design of a type of engine for colliers and vessels of

that type has been undertaken, and the engines of the *Kanawha*, mentioned above, are based on this design.

The electrical propelling machinery of the *Jupiter*, at the date of this report, is ready for trial, and the results of the experience with it are expected to furnish valuable information regarding the adaptability of this type of machinery for naval vessels. Being the first installation of the kind on such a large scale, the trials will be watched with great interest by marine engineers in general, and it is hoped that the experiment may be of such a satisfactory character as to justify the further installation of this type of machinery.

The use of oil as fuel has continued, and all the latest designs of battleships, as well as destroyers, provide for the use of oil only. The admirable work carried out at the oil-fuel-testing plant, Philadelphia, has been productive of much valuable information on the subject of oil burning, and, supplemented by the experience in destroyers, has resulted in the development of an oil burner and air register which have given excellent results in service from an economic standpoint, and have effected a marked improvement in smoke reduction.

Some improvements have been made in the design of bureau type gasoline (petrol) engines which have contributed to efficiency of operation and have also resulted in reducing the cost of manufacture.

New Construction

Work on the machinery for the battleship *New York* has proceeded in a most satisfactory manner at the New York Navy Yard, and its installation is now in progress. The only other yard where the construction of machinery is now carried on is Mare Island. There the machinery of the river gunboats *Monocacy* and *Palos* is well advanced, and that of the collier *Kanawha* only recently begun.

Electrical Work

Thorough consideration has been given the subject of improving the lighting and wiring of ships, with the result that leaded and armored conductors have been adopted instead of plain conductors run in conduit, and that lighting fixtures have undergone complete redesign. In the consideration of this subject the bureau enlisted the co-operation of the foremost lighting engineers of the country, whose suggestions were given the fullest consideration, and it is believed that the progress which has already been made will result in greatly improving the lighting conditions on board ship.

The efforts that have been made to reduce the cost of searchlight mirrors by purchasing them in quantity sufficient to meet the demands of the fleet for a period of time have not only effected this purpose, but have also resulted in the production of mirrors in this country which it is confidently expected will be equal in efficiency to those formerly purchased abroad. This is a matter of no small military importance, but as it is accompanied by a marked reduction in cost, the commercial aspect of the case is none the less gratifying.

The number of searchlights on all battleships has been reduced from 16 to 8, and those which have been removed from ships having 16 searchlights will be used in bringing other battleships' and destroyers' searchlight equipment up to what is considered the standard. All of the older destroyers are to be modified by the installation of larger searchlights than they now carry.

Fuel Oil

The established policy of the department being that all battleships and destroyers shall use oil fuel exclusively, it is becoming a matter of the first importance to assure an adequate supply at a reasonable price. The price of oil is advancing so rapidly as to increase materially the navy's expenditure for fuel, and with the increasing demand for petroleum products further increase in the price of oil may be anticipated. To counteract this in small measure the navy might use oils not so well suited for its needs, but this would be at a sacrifice of efficiency, and some of the advantages that are to be secured with good oil would have to be sacrificed. The only method of insuring cheap oil embodying the refined products most adaptable to smokeless high-speed running appears to be to begin our own producing and refining, and in order to accomplish this it is strongly recommended that the department take the steps necessary to lease oil lands and to establish and operate a refinery. If this is done the sale of gasoline (petrol) and illuminating oils obtained from the crude oils, and which are not needed in fuel oils, will, it is believed, go far toward covering the expense of operation, and the navy will thus obtain a grade of oil in every respect suitable for its use, and at a cost far below the present price.

Tests of Subaqueous Coal

The coal stored at New London has been given an annual evaporative test during the two years it has been stored there, and no difference in evaporative efficiency has been shown between that stored under cover and that under water.

Launch of the Blavet

On Aug. 6 the Ateliers & Chantiers de Bretagne launched from the yard of the Pont Tournant the steamer *Blavet*, built to the order of the Société de Bois & Charbons F. Lebrise, Lorient. The vessel is especially designed for carrying coal between Lorient and the Bristol Channel. She is of the well-deck type, and has been built under the special survey of the French Veritas. The main particulars are:

Length over all	221 feet 6 inches
Length between perpendiculars	213 feet 3 inches
Breadth	34 feet 6 inches
Depth at main deck	14 feet 5 inches
Draft at full load	13 feet 2 inches
Displacement at full load draft	2,165 tons
Deadweight	1,200 tons
Gross tonnage	1,125 tons
Indicated horsepower	755

The hull is divided by transverse bulkheads into five watertight compartments. A double bottom with a capacity of 240 tons of water for ballast extends throughout the length of the ship. There is only one deck, and large hatches are provided. served by derricks of 1½ tons lifting power actuated by steam winches.

Steam is supplied to the main and auxiliary machinery by two cylindrical boilers, working under natural draft at a pressure of 185 pounds per square inch. The total grate area is 73.59 square feet and the heating surface 2,218 square feet.

The main engine is of the triple-expansion type, with cylinders 15, 25 and 40 inches diameter, with a common stroke of 26 inches. At a speed of 120 revolutions per minute the engine develops 775 indicated horsepower. The propeller, of the four-bladed type, is 10 feet in diameter.

A crew of fifteen, including the captain, is carried, and accommodations are provided for the owner. The officers' quarters are above the chart room, while the engine-room staff is berthed around the engine enclosure. The crew's quarters are forward in the forecastle.

The ways on which the vessel was launched had a total length of 246 feet and a declivity of 7.5 percent. Twenty cables, each having a breaking strength of 20 tons, were arranged to check the progress of the ship down the ways, but only sixteen were broken when the ship was brought to rest at a distance of 100 feet from the end of the ways.

Launch of Japanese Battle Cruiser.—The battle cruiser *Haruna*, of 27,500 tons displacement and 28 knots speed, was launched at Kobe, Japan, Dec. 5

Notes on the Performance of the S. S. Tyler

A Plea for Adequate Trial Trips of Merchant Vessels—Trial Data from an Interesting Cargo Steamship Built for the Old Dominion Line

BY E. H. RIGG

The comparative scarcity of accurate and full accounts of the performances of ships built in the various yards has frequently been deplored in connection with papers read before this and kindred societies. This point came up in connection with the short paper read here by myself last year, and it is more to follow up one point then brought forward that the present paper has been prepared rather than on account of any extraordinary interest or originality attaching to the following remarks and figures.

It is comparatively an infrequent occurrence for trial data of merchant ships to be allowed publicity, and the thanks of the author are due to the Old Dominion Steamship Company, the owners, and to the New York Shipbuilding Company, the builders, not only for permission to record here the results achieved, but also for co-operation in furnishing the information necessary for comparative purposes.

In a paper entitled "Notes on Fuel Economy as Influenced by Ship Design," read before this society at the general meetings last year, reference was made to the vessel which forms the subject of the present paper. Certain hopes were indulged in as to her performance as a coal saver, compared with similar vessels; since that time she has been completed for sea, run her trials, and been in service long enough for results to be available, and it is hoped that these will not be without interest to members of the society.

Reference to page 233 and Plate 95 of our 1912 Transactions will give details of the lines and of the model experiments carried out during the design stage of this vessel. Later it was decided to build the vessel 331 feet long between perpendiculars; whereas a model representing a 308-foot 6-inch ship had been towed. This change introduces a necessity for careful calculation to get the effective horsepower for the longer ship. The curve of effective horsepower herewith has been deduced as follows:

Both ships were worked up from Taylor's standard series. A percentage difference between the model as towed and the shorter ship calculations was obtained and applied to the longer ship calculations to get the required curve, which, therefore, represents the ship as built.

In laying down the *Tyler*, middle body was added to obtain the new length; the bilge lines were eased, so that there is, strictly speaking, no parallel middle body. On the floor and sides, however, there is some fifty feet of parallel body, or 15 percent, which is the figure for minimum residuary resistance, the easing of the bilge being so slight that the vessel has this amount of parallel body for all intents and purposes.

In the 1912 paper a claim was made for a 3 percent saving, due to the forward lines; the trials at the Delaware Breakwater amply justify this claim; recent average practice would require at least 2,000 indicated horsepower for 12¾ knots; 1,750 indicated horsepower, as realized, therefore represents a 12½ percent saving, all of which, however, is not claimed for the bow lines; it would not be difficult to cite similar cases requiring 2,100 indicated horsepower for this speed.

It is to be regretted that there is no other ship in the Old Dominion fleet that can be compared directly with the *Tyler*. The *Madison* is a larger vessel, passenger carrying, and four knots faster. These ships compare approximately as follows:

	Madison	*Tyler*
Length	359 feet 0 inches	331 feet 0 inches
Breadth	42 feet 0 inches	47 feet 0 inches
Draft	16 feet 6 inches	16 feet 6 inches
Displacement	4,500	4,750
Sea speed (knots)	16	12
Indicated horsepower	4,000	1,750

Both vessels have a single screw. These figures are included more to show the difficulty of comparison than as an actual comparison. From effective horsepower curves from a previous vessel it is, however, possible to arrive at a fair comparison. The type vessel is similar to the S. S. *Madison* in general form.

Item	*Type*	*Tyler*
Length	350 feet 0 inches	331 feet 0 inches
Breadth	42 feet 0 inches	47 feet 0 inches
Draft	17 feet 10 inches	16 feet 11 inches
Displacement	4,875	4,875
Block coefficient	.65	.65
Speed in knots	13	13
Effective horsepower	1,100	1,200
Ratio, beam to draft	2.36	2.78
Speed length ratio	.695	.715

The *Tyler* is shorter and wider than the type ship and only requires 100 more horsepower for the same speed at the same displacement. Both these performances are creditable to the designers, but especially so in the case of the shorter and wider vessel. The *Tyler* is an example of a case where several cooks did not spoil the broth.

Besides the Old Dominion Steamship Company and the builders of the vessel, Naval Constructor D. W. Taylor and the Newport News Shipbuilding Company had a hand in preparing the lines of the vessel.

Turning to the propeller side of the question, the propulsive efficiency at 12¾ knots is seen to be some 63 percent, which, I think, will be admitted, is a good performance.

In warship trials an accurate curve of effective horsepower is generally available, but only very rarely for merchant ships; this fact renders the *Tyler's* trials decidedly more interesting.

The propeller data will be found in Table 1; the builders were responsible for its design.

The mean depth of water on the course was some 165 feet; information from shoal water trials shows that this is an ample depth for the draft and the speeds attained; the results are therefore not complicated by shoal water effects. The mean depth on the approaches was about 110 feet and this figure also is reasonably satisfactory. The approaches refer to a length of one mile each side of the range buoys. Minimum suitable depth for this vessel is about 125 feet. The service in which these vessels are engaged is a coastwise one, between New York City and Norfolk, Va.

Since the vessel has been in service she has made frequent trips at a mean draft of 17 feet, and has made a speed of slightly over 12 knots between the lightships. I hope Mr. Higgins will be able to supplement these figures with later data on her sea performances.

Table No. 1

Hull and Machinery Data

Length over all	344 feet 0 inches
Length between perpendiculars, W. L.	331 feet 0 inches

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

Beam, molded	47 feet 0 inches
Depth, molded	35 feet 0 inches
Draft, aft, on trial	17 feet 11 inches
Draft, forward, on trial	15 feet 11 inches
Draft, mean, on trial	16 feet 11 inches
Trim by stern	24 inches
Corrected displacement ......(long tons)	4,875
Freight earning deadweight...(long tons)	2,350
Block coefficient	.650
Longitudinal coefficient	.682
Wetted surface ....(square feet)	20,000
Engine, triple expansion.	
Cylinders .... 19¾ inches, 33¼ inches, 58 inches	
Stroke	42 inches
Boilers, S. E. Scotch.......(number)	2
Heating surface, total...(square feet)	4,182
Grate surface, total.....(square feet)	105
Draft, heated forced.	
Working pressure ....(pounds)	200
Dimensions, 13 feet 8 inches diameter, 12 feet 0 inches long	
Propeller, four-bladed, solid, cast steel.	
Diameter	14 feet 6 inches
Pitch	14 feet 6 inches
Projected area ....(square feet)	66.7
Developed area ....(square feet)	80.0
Gross tonnage	3,928
Net tonnage	2,960

TABLE No. 2

Results on Standardization Trials. Delaware Breakwater Course, Aug. 3, 1913.

(Weather, clear and warm; calm sea; light westerly breeze; ranges clearly visible.)

Run and Direction.	*Elapsed Min.*	*Time Sec.*	*Revolutions Per Minute.*	*Indicated Horse-power.*	*Knots.*	*Slip Percent.*
1—N	7	10.2	59.15	438	8.368	1.108
2—S	8	12.5	57.53	424	7.310	11.270
Mean			58.34	431	7.839	6.189
3—N	5	33.2	74.35	746	10.804	—1.55
4—S	6	42.3	75.30	850	8.948	16.95
Mean			74.82	798	9.876	7.70
5—N	4	39.8	83.00	1128	12.866	—8.31
6—S	6	14.0	82.95	1118	9.626	18.87
Mean			82.97	1123	11.246	5.28
7—S	4	49.5	92.90	1605	12.435	6.45
8—N	4	59.2	92.80	1602	12.032	9.43
Mean			92.85	1604	12.233	7.94
9—S	4	26.2	95.95	1788	13.524	1.509
10—N	5	17.2	94.75	1682	11.349	16.360
11—S	4	05.2	95.65	1723	14.682	—7.29
12—N	5	35.4	95.90	1806	10.733	21.85
True Mean			95.38	1750	12.793	6.345

NOTES ON STANDARDIZATION

1. After run No. 6, the vessel hauled off to await the change of the tide from flood to ebb; 2¾ hours elapsed between end of No. 6 and beginning of No. 7.

2. Runs Nos. 7 and 8 were thrown out in plotting the speed and power curves; it was noticed that the tide had not set down and was still running oblique to the course. It is to be noted that the revolutions and power spots check well, but the speed is evidently not correct; the slip curve also bears this out.

3. Four high-speed runs were made and a mean of means taken; this establishes the top spot beyond question.

4. On run No. 9 the *Tyler* and the *Narragansett* passed on the course, one to the west and the other to the east of the buoys; it is probable that each affected the other slightly.

5. On run No. 10 it is to be noted that the steam pressure dropped back and consequently the indicated horsepower fell about 100 below the average for the other three high runs. Full pressure would have made the top speed 12.875 knots.

TABLE No. 3

Propulsive Efficiency

From the above data the efficiency figures are as follows, taking the ratio between total effective and indicated horsepowers:

R. P. M.	*Speed in Knots.*	*E. H. P.*	*I. H. P.*	*Efficiency in Percent.*
60	8	270	460	58.7
67	9	380	625	60.8
74	10	520	820	63.4
81½	11	685	1060	64.6
89	12	875	1385	63.2
97½	13	1190	1870	63.6

Displacement, draft, etc., will be found in Table No. 1.

It will be noted that at top speed the propeller shows no signs of breaking down.

Electric Propulsion on S. S. Jupiter*

BY W. L. R. EMMET

When the first tests of the *Jupiter* operation were made she had been lying at the Navy Yard dock for four months, so that her bottom was in a very foul condition. Her speed in that condition was something like 25 percent below normal. This produced abnormal electrical conditions, since the low frequency made necessary the use of higher magnetic densities than are desirable. Many of the conditions of these runs were very unfavorable. A large proportion of the crew were green men; in one fireroom watch a large proportion of the fireroom force were seasick. A great deal of boiler compound was used in the boilers, and the priming was excessive. The condensed water was much discolored by boiler compound, and water was at frequent intervals forced from the valve packings.

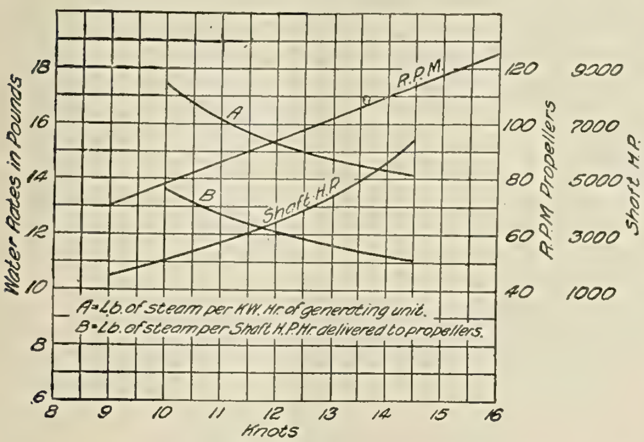
The operation of the apparatus during these runs was exactly in accordance with expectations. The turbine ran with a very perfect balance, and ran just as steadily in rough water as in smooth. The governor held its speed perfectly. The lifting of the propeller to the surface at no time caused any perceptible speed variation. The only effect of such lifting of propellers was a fall of current on the instruments showing a diminution of power delivered to the propellers. Examination of the turbine after several such runs had been made showed it to be in perfect condition and free from rust, scale or dirt.

After this period of preliminary trials the ship was docked and since that time she has made a set of standardization runs and a 48-hour unofficial trial with a clean bottom. On this 48-hour trial the ship averaged 14.78 knots, the average power delivered by the generator was 5,000 kilowatts, corresponding to about 6,300 horsepower. The average revolutions of the propeller were 115. The *Cyclops* in her official 48-hour run made 14.61 knots, with an average of 6,705 indicated horsepower.

The power required by the *Jupiter* in this 48-hour run is somewhat less than would be expected from the *Cyclop's* performances, and the slip of the propellers is also less than was expected. It has been suggested that this difference might,

*From a paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913. For a description of the *Jupiter* and her machinery see INTERNATIONAL MARINE ENGINEERING, August, 1913, page 323.

in some degree, be attributable to the fact that in the *Jupiter* the torque delivered to the propellers is continuous, while with the reciprocating engines the impulses are intermittent. Careful investigation would be necessary to ascertain whether there could be anything in such a theory. It has also been suggested that there would be some advantage in the fact that the *Jupiter's* propellers were entirely free from racing, but since some of these tests were made in quite smooth water this could hardly have had any effect. If no advantage is gained through these causes it would certainly seem that the



Water Rates U. S. S. *Jupiter*—Conditions 190 Pounds Gage, 28.5 Inches Vacuum, No Superheat

performance of the *Jupiter's* propellers is very creditable to Captain Dyson, who designed them.

Through a misunderstanding the steam pipe on board the *Jupiter* was made much too small, so that the normal pressure at the turbine cannot be attained. The vessel will not give her best performances until this is corrected, and until an effective separator is put between the boiler and the turbine so that the efficiency of the turbine will not be affected by priming. It is believed that when these changes are made the *Jupiter* can, if desired, be operated at a much higher speed than that which has been attained, and that her economy will prove to be far better than that of any vessel afloat.

The steam consumption of the *Jupiter* turbine and the efficiency of all her apparatus have been determined by exhaustive tests at Schenectady, and is also accurately known through knowledge of the performances of other similar apparatus. These results are shown by the accompanying curve, and they cannot fail to be accomplished in the ship herself when all conditions are normal.

Since the preliminary trials above mentioned, the *Jupiter* turbine has been injured through the breaking of a half-inch top bolt, which held the section of stationary buckets used in the first stage of this machine. On account of this trouble her official trial has been postponed, and it is hoped that the steam pipe will be changed and a separator put in before the official trial is made. A section of stationary buckets held by these bolts is the only detachable part in this turbine. Tap bolts are subject to the danger of breaking under such conditions, and we have had trouble with such method of attachment in other turbines. The matter in this case was, however, unfortunately overlooked. The trouble is easily corrected, and the accident has no significant bearing upon the demonstration which this ship has made. While this bolt destroyed all the buckets in the first stage, the turbine was still capable of operation. The turbine was taken apart because it was seen that the economy was not normal. By taking out the bolt which was adrift and clearing the damaged parts which might interfere, the ship could still have been operated indefinitely at normal speed with a very fair economy. Such arrangements could be made in a few hours.

Four years ago I presented my first paper on Electric Ship Propulsion to this society. A year before that I had designed an equipment for the battleship *Wyoming*, and a proposal had been made to the Government in which my designs were embodied. Since that time I have submitted several designs to the Government relating to equipments of battleships which have been built. My last design applied to a case like that of the *Pennsylvania* and was submitted last spring. My estimates as to the result of this equipment as compared with those which will be accomplished by the equipment which is being put into the battleship *Pennsylvania* are shown by the following table:

	Turbine drive with geared cruising turbines as adopted.	*Turbo-electric drive.*
Revolutions per minute, 21 knots......	222	160
Horsepower required, 21 knots........	31,700	29,200
Pounds of steam per hour turbines alone, 21 knots......................	374,000	305,000
Pounds of steam per hour turbines alone, 15 knots......................	106,000	91,000
Weight of driving machinery in tons..	749	598

With reasonable allowances for steam required outside of the main turbines it would appear that this ship, which is provided with 12 boilers, could, with the turbo-electric equipment, operate equally well with 10 boilers. If two boilers were omitted the whole weight saving would be 266 tons.

The Upkeep and Management of Boilers on a Tramp Steamer

At a meeting of Institute of Marine Engineers on Dec. 1 a paper on "The Upkeep and Management of Boilers on a Tramp Steamer," by Mr. G. A. O'Neill, was read. In dealing with the question of internal corrosion the author stated that sufficient care was not always taken, when fitting zinc plates in the boiler, to clean away the dirt and scale from around the necks of the stays so as to form a metallic contact. Soda was often used without any consideration as to the amount required. This could easily be ascertained by the use of litmus paper. The pitting frequently found along, and a little above, the line of the firebars on the water side of a furnace, could be arrested by making it a practice to clean thoroughly and remove the black scale, afterwards coating with a mixture of metallic zinc powder and clean fresh water. He did not agree with the practice of scaling furnaces only to the line of the firebars, and leaving the bottoms untouched. In modern ships a great many of the difficulties were eliminated by the use of independent feed pumps and efficient feed heaters.

It was quite a common rule in raising steam to light the fire in the center low furnace of a three-furnace boiler four or five hours before the others, but with the modern appliances for artificial circulation this practice was entirely unnecessary. It was also harmful by setting up undue strains on the front end plate. The bottoms of the combustion chamber on the fire side were liable to corrosion if not carefuly watched. Salt from leaky tubes and joints, when mixed with wet ashes, set up corrosion, and it was essential that any leaks noticeable should be stopped at the first opportunity. Corrosion at the bottom front end plates could be eliminated to some extent when at sea, if the ashes were removed from the furnace fronts immediately after the fires were cleaned, and not allowed to remain there until the end of the watch, as was often the case.

Naval Architects' Annual Meeting

Abstracts of Interesting Papers Read and Discussed at Well-Attended Meeting of Naval Architects and Marine Engineers, in New York

The twenty-first annual meeting of the Society of Naval Architects and Marine Engineers was held in the Engineering Societies building, New York, Dec. 11 and 12. Morning and afternoon sessions were held each day and the meeting closed with a banquet at the Waldorf Astoria Hotel Friday evening, Dec. 12. On account of the illness of Col. Robert M. Thompson, president of the society, the meeting was presided over by W. M. McFarland, vice-president. According to the annual report of the secretary-treasurer, the membership of the society now stands at 770 as against 731 last year, and the total resources amount to $23,446.05 (£4,800) as against $18,000 (£3,700) last year. Through death the society has lost the following members:

Sir William White, honorary member; Charles H. Cramp, George W. Quintard, life members; Edwin S. Alexander, Thomas F. Carter, Edwin S. Cramp, William H. Fletcher, Robert Forsyth, Frank D. Hall, Valdemar F. Lassoe, members.

The following papers were read and discussed:

Relative Resistances of Some Models with Block Coefficient Constant and Other Coefficients Varied

BY NAVAL CONSTRUCTOR D. W. TAYLOR, U. S. N.

This paper is published on page 7.

Resistance of Bilge Keels

BY PROF. C. H. PEABODY

Abstract

The experimental boat *Fulton* was used during the past summer to investigate the resistance of bilge keels, for which purpose it was well adapted both by the precision of results possible and because the stream lines are known.

The normal bilge keels were made 15 feet long and 3 inches deep; bilge keels 6 and 9 inches deep were also tested. Tests were made in addition on keels 3 inches deep and 19 feet long.

The apparatus on the *Fulton* is that described on page 87, volume 19 of the Transactions. The primary observations taken were: (1) Time on the course; (2) thrust of the propeller; (3) revolutions of the propeller, and (4) input to the electric motor.

The assembling of results was conveniently made by plotting all observations with revolutions for abscissæ. Sample curves are given of (1) speeds in knots per hour; (2) thrust of the propeller shaft in pounds, and (3) input to the electric motor in kilowatts. The first curves show a slight current at times, due probably to a wind acting before the tests; this current was in all cases less than a tenth of a knot per hour; it necessitated runs both with and against the current, from which the mean speed was definitely determined. The thrust was found to be practically the same for a given number of revolutions in all cases, with bare hull and with the several keels; consequently the thrust curve was well located. The determination of power (input to motor) was quite satisfactory; tests made at an interval of two weeks gave identical results.

In order to obtain results as indicated it was found necessary to run only when weather conditions were ideal; though such conditions might come at any time, day or night; the conditions were most frequently found at 4 o'clock in the morning.

The results of the experiments are reported in two forms:

(1) The ratio of the increment in propeller thrust, due to the addition of a given pair of bilge keels, to the computed frictional resistance of the keels.

(2) The ratio of the increment in power on account of the addition of a pair of bilge keels, to the computed power to overcome the friction of the keels.

For speed less than that corresponding to a speed length ratio 0.7 the increment in thrust corresponded well with the computed resistance of the keels; at higher speeds the resistance was greater than that due to friction up to a ratio of 1.5. The increment in power, due to addition of bilge keels, was notably larger than the power computed from the friction of the keels, the ratio varying from 2.5 to 3.5, the larger ratio being found at the higher speeds. The discrepancy between results from thrust and from power cannot be charged to error or uncertainty of observations or to methods of reduction, but is a real difference.

On the Possibility of Building a Large Passenger Liner That Would Not Under Any of the Known Mishaps at Sea Lose Her Buoyancy or Stability and Sink

BY GEORGE W. DICKIE

Abstract

This paper seeks to point out a possible solution of the above problem as applied to a certain type of vessel, viz., the large, modern, passenger liner. New and ever-increasing laws concerning life-saving appliances have created a grave problem for the naval architect, both as to carrying heavy top weights and littering a large area of deck space with lifeboats and rafts. In brief, the suggestions embodied are the fitting of a double upper deck, and so arranging the watertight subdivision below the lower member of this deck that the ship would prove both seaworthy and unsinkable under the most aggravated conditions of flooding. The advantages to be considered in this arrangement as opposed to the drawback of wasted space are as follow: The space between the two members of the upper deck would be utilized for cold-storage rooms, air ducts, water and steam piping, stores, etc. The fire mains would at all times be under direct control. All horizontal piping and ducts through living spaces would be done away with. Communication to and from engine room, fire rooms, dynamo room and ventilating and refrigerating rooms would be through a continuous watertight passage fitted with automatic watertight doors which would operate from the influx of the sea. In a ship so constructed, and practicably, at least, unsinkable, would it be necessary to carry the great number of lifeboats now deemed necessary, and which, with the great freeboards of our ocean liners, are utterly useless except in the event of moderate sea and the speedy arrival of assistance?

Structure of Vessels as Affected by Demand for Increased Safety

BY WILLIAM GATEWOOD

This paper is published on page 21.

Stability of Lifeboats

BY H. A. EVERETT

Abstract

This paper presents the results of inclining experiments and subsequent stability calculations upon four types of 28-foot lifeboats: First, standard metallic; second, standard wooden; third, decked metallic, and, fourth, collapsible wooden.

Two conditions for these were taken—light, and loaded to their rated capacity. In the loaded condition the first three types showed good stability with a range of about 30 degrees

before the vanishing point was reached, and with the decked type giving the greatest curve of dynamical stability.

The curves are normal and quite what one would expect, though it is of interest to note the very appreciable increase in stability which is caused by the seating of about one-third the passengers on the bottom of the boat instead of on the thwarts and seats provided for them. It is noticeable, also, that the wooden boat has less stability than the metallic, though of the same external form. This was caused partly by the center of gravity of the boat itself being somewhat higher and partly by the fact that the thwarts and seats were about 1 inch higher above the keel than in the metallic boat. The construction plans show no reason why the thwarts and seats should not be lowered appreciably, and it would seem desirable to have them as low as possible.

For example, the wooden boat from the cross curves has an uncorrected righting arm, when loaded with fifty people and inclined at 30 degrees, of 0.90 foot. The distance of the center of gravity above the assumed axis of inclination is 11 inches, or 0.92 foot. The correction for the righting arm is then 0.92 $\times$ sin 30 degrees $=$ 0.46 foot, and the corrected righting arm is 0.90 — 0.46 $=$ 0.44 foot. Now, if the thwarts were lowered 6 inches the resultant center of gravity would be lowered 0.35 foot, in which case the correction would be 0.57 $\times$ sin 30 degrees $=$ 0.28 foot, and the corrected righting arm would be 0.90 — 0.28 $=$ 0.62 foot, which is an increase in statical stability of about 40 percent.

The curves of dynamical stability of Plate 9 give the most comprehensive comparison of the merits of the different types from the stability viewpoint. The collapsible boat sank with less than the allowed load on board, and had practically no stability with less than one-third the allowed load, as the angle of zero stability was 3 degrees.

The failure of this boat was undoubtedly due to water leaking into the chamber between the decks. The essentially vicious feature, from a construction point of view, is that in any wooden boat subject to the ordinary weather and wear encountered in normal service, leakage is bound to occur, and this leakage coming into a space from which no provision is made for bailing, insidiously diminishes the craft's stability and seriously impairs its buoyancy. The bulwarks are not intended to be watertight, and the stability curve when light has all the characteristics of that of the raft with its quick-rising curve of righting moments for very small angles, reaching zero stability at an angle vastly less than the standard type of boat.

A Substitute for the Admiralty Formula

BY E. A. STEVENS, JR.

ABSTRACT

This formula was derived from the Admiralty formula as follows:

$$I.\,H.\,P. = \frac{D^{2/3} \times V^3}{C}, \text{ or } V = \sqrt[3]{\frac{I.\,H.\,P. \times C}{D^{2/3}}}$$

Now

$$D^{2/3} = \frac{D^{5/6}}{D^{1/6}} = \frac{D^{5/6}}{\sqrt{D^{1/3}}}$$

As the length of vessels of similar models varies as $D^{1/3}$, L (or length $L\ W\ L$) was substituted for this factor, which gives

$$D^{2/3} = \frac{D^{5/6}}{\sqrt{L}}$$

Now, substituting this value of $D^{2/3}$, and taking C out of the radical, we get

$$V = C\sqrt[3]{\frac{I.H.P. \times \sqrt{L}}{D^{5/6}}}$$

In order to simplify the formula, $D^{5/6}$ was replaced by D.

Tables Nos. 2, 3, 4 and 5 show the values of C as worked out for several types of vessels.

Tables Nos. 9 and 10 and Plates Nos. 3 and 4 give, the writer believes, a very fair comparison of the relative accuracy of the new formula and the Admiralty formula.

By simple solutions of the formula for values of its various terms it appears that for ships of

(1) Same length and displacement, power varies as V^3.

(2) Same length and speed, power varies as D.

(3) Same speed and displacement, power varies as $\frac{1}{\sqrt{L}}$.

In presenting the formula, the writer does not claim that it is an accurate means for estimating the speed of ships, but merely one that can be used for preliminary calculations in place of the Admiralty formula with more accuracy. It is also easy to handle and requires less judgment and experience in its application.

The Evolution of the Lightship

BY GEORGE CROUSE COOK

ABSTRACT

The text of this monograph consists of a brief statement of the functions of the lightship as an aid to navigation, an outline of its origin and development, and a description of the first-class lightship, designated Lightvessel No. 94, of the United States Lighthouse Service. The illustrations consist of a sketch of the first-known lightship and the plans of Lightvessel No. 94.

Especial attention is invited to the following paragraphs:

In 1856, a paper, "The Form of Stationary Floating Bodies," was read at the Institution of Civil Engineers, London, proposing a circular vessel for a lightship. The discussion which followed developed a wide diversity of opinion as to what form was the most desirable. * * * Scott Russell, the distinguished naval architect of his day, spoke at some length, and said that he "would be inclined to give a lightship great length, with a safe but small section, and extremely fine lines."

Again in 1860, the question of lightship design received serious consideration in England. A "Royal Commission on Lighthouses" was appointed to inquire into matters pertaining to the lighthouse service. In the course of its investigations it sent out a series of questions to the distinguished "scientific men" of the day, including Rankine, Faraday, Herschel, etc. One of these questions referring to the lightship called for "opinions on the best form for the hull." The replies were most varied. * * * Some advocated longer vessels, others shorter; some recommended much sheer, others less; some favored bluff bows, others sharp, etc.; while several advised circular hulls moored at the center of gravity. Among the advocates of the last was Professor Rankine, of the Glasgow University.

A second question, "At what part of the vessel should the moorings enter?" elicited a variety of opinions; and hawse holes at a considerable height above the water, close to the water, and also under the water were proposed.

The practice of the United States Lighthouse Service in these features of design is indicated by the line draft, the curves of form, and the stability diagrams of Lightvessel No. 94, shown on Plates 3, 4 and 12.

The author repeats, again, the questions raised in 1860: What is the "best form for the hull"? and "At what part of the vessel should the moorings enter?" and invites discussion thereon by the members of the society.

Construction and Operation of Western River Steamers

BY RICHARD CLARKE WILSON

ABSTRACT

This paper is not considered a technical effort, but is presented merely as a criticism, or rather an explanation, of the

medieval mode of handling and also building the present type of boats on Western rivers, and it is endeavored to show a mechanical solution of the cause of the gradual diminution of the river traffic.

The designs were so completely covered in the paper by Mr. Charles Ward, read before the Detroit Summer Meeting, that it is believed to be useless to go into any sort of details of construction. The same types and construction prevail, and will for years, as the older captains and others concerned in the operation and maintenance are bound to hold tightly to what they have, and what their fathers and grandfathers had before them.

The Influence of National Policies on Ships' Design

BY CAPTAIN W. L. RODGERS, U. S. N.

Abstract

1. This influence has been marked at all periods of history.
2. Historical examples:

Actium, 31 B. C.
Spanish Armada, 1571 A. D.
American Civil War — show that policy rules types of ships.

3. Lack of control of ship design by national policy in United States during period from Civil War to Spanish War led to unsuitable types.
4. Present arrangements in Navy Department to ensure that general military characteristics of ships shall be such as best to support national policies.
5. Example taken from history of German ship building shows that foreign powers build their navies with definite foreign policies in view.
6. Conclusion that naval architests must keep in close touch with the exponents of national policy.

Strains in Hull of Ship at Sea and those Measured While Receiving Cargo

BY JAMES E. HOWARD

Abstract

The paper presents the results of measurements made on the plates of the shelter deck of the steamship *Ancon,* of the Panama Railroad Steamship Company,. on the voyage from New York to Colon and return, also observations on the deck plates during the time the ship was taking cargo aboard at New York.

Live load strains on the deck plating while at sea were made with a new type of live load extensometer, a scissors gage, so called from the resemblance of its working parts to a pair of scissors. This instrument has an ultimate sensitiveness of one-hundred thousandth of an inch. The strains in the deck, observed during the time of taking aboard cargo, were measured with a strain gage of telescopic tube type with micrometer screw attachment, having a sensitiveness of one ten-thousandth of an inch.

The observations made at sea embraced those taken on the shelter deck, forward and aft of the superstructure, showing the longitudinal changes on gaged lengths of 6 inches each, which took place due to the pitching of the boat and vibrations which were due to the rotations of the engines. These measurements were made both on the solid plates and spanning the lap joints of those plates.

On the outward trip the ship carried a full cargo of about 10,000 tons. It was found with this load, and during good weather with a smooth sea, that the rotations of the engines caused the development of greater strains in the deck than those which were due to a moderate pitching of the boat.

The measured strains reached a maximum in the vicinity of the after bulkhead of the superstructure, where they corresponded to a stress of 2,250 pounds per square inch, on Course B of the plating. The strains over lap joints in this vicinity were twice those observed on the solid metal of the plates. These longitudinal strains were less on plates farther aft and ceased to be measurable before reaching the stern.

On the forward part of the ship the strains in the solid plates, Course C, ranged from 100 to 650 pounds per square inch, according to position, but disappearing as the bow was approached. Greater rigidity prevailed in the stringer course of plating and across the butt joints of that course, both forward and aft, than in the lap-jointed plates.

A few observations were made prior to the main series, when a moderate sea was running, which showed stresses in after part of the deck near the bulkhead ranging from 2,500 to 3,500 pounds per square inch. The greatest stress found during these observations was on the angle of the bulwark rail, immediately aft the superstructure, where a range of 5,500 pounds per square inch was observed.

While the live load strains on the outward trip were greater, due to the rotations of the engines than those caused by the pitching of the boat, the reverse was the case during the return trip from Colon to New York. Northbound, the boat carried only about 3,000 tons cargo. The pitching strains then were generally double those due to the rotations of the engines. On each trip they were greatest in the vicinity of the after bulkhead of the superstructure.

Strains due to pitching and those due to the engines were distinguished by their periodicity. The engines made 78 rotations per minute, and the strains attributed to them were developed synchronous with the rotations.

For the purpose of determining the strains in the deck plates at the time of receiving cargo, reference lengths were established, of 20 inches each, on three courses of plating and on the bulwark rail of each side of the ship. These observations extended over a period of seven days, during which time a wide range in the temperature of the deck plates was experienced. The highest temperature was 116 degrees F., the lowest 60 degrees F. The greatest range in stresses occurred on the stringer plates—results ranging from 4,000 to 4,800 pounds per square inch being observed. The behavior of the deck was such as to lead to the belief that variations in temperature were responsible for the largest part of the stresses rather than being due to the cargo.

Apparently, a change in stress amounting to 2,500 pounds per square inch, occurred on the rail of the boat in rising from a temperature of 60 degrees in the morning to 90 degrees at the middle of the afternoon.

These last observations were generally made in the morning, about sunrise, to secure conditions when minimum differences in temperature existed.

Change of Shape of Recent Colliers

BY NAVAL CONSTRUCTOR STUART FARRAR SMITH, U. S. N.

Abstract

This paper contains the results of observations of hogging and sagging on some of the 500-foot colliers recently built for the United States navy. It shows that the upper deck, at the middle of the length, may move up or down as much as 6 inches with reference to the ends, depending on the conditions of loading; and that a temperature rise of 1 degree F. may cause the deck to rise ⅛ inch. It contains some observations of the motion of the tank top with reference to the upper deck, and suggests that more extended observations of these points may permit of working backward from the girder deflection and loads to the actual fiber stresses, thus checking the preliminary strength calculations.

General Organization of Navy Yard Design, Location, Capacity and Maintenance, with Plan and Description of a Large, Efficient Yard Properly Located

BY CAPTAIN L. S. VAN DUZER, U. S. N.

Abstract

This paper has been prepared to show that we must have at least one large navy yard where the entire fleet can be effectively repaired and supplied in time of war. That fact being admitted, the question is considered from the three principal

points of view, viz.: (1) Suitability of location; (2) capacity of yard, and (3) cost of construction, maintenance and operation.

After considering the various requirements, it is pointed out that the position of New York is superior to all other ports on the east coast. It is, however, maintained that a better location may be obtained for the creation of a new navy yard at Communipaw, N. J., than is afforded by the present location in Brooklyn. The new yard would be a mile or two further away from an attack by sea and also close to all the great trunk lines of the country. It would still possess the advantages of the labor supply afforded the Brooklyn yard.

The great opportunity of designing a new, modern and up-to-date establishment for the construction and repair of ships is shown, and a tentative plan is presented. It is declared that the great expense of the new navy yard would be for the most part covered by the price obtained from the sale of the old navy yard.

Notes on the Performance of the S. S. Tyler

BY E. H. RIGG

This paper is published on page 29.

Historical Notes on Chain Cables

BY ASSISTANT NAVAL CONSTRUCTOR JOHN E. OTTERSON, U. S. N.

Abstract

The above paper contains brief notes as to the history of chainmaking, as to the theory of stresses in the chain link; the relative advantages of open and stud-link chain, of end-welded and side-welded chain; a description of the present hand process of manufacture; the extent to which machine processes have been developed to date; and notes as to certain experimental work carried on at the navy yard, Boston, looking toward the development of a satisfactory machine process and toward the producing of chain of a more uniform and reliable quality. The paper also indicates the advantages to be gained by the proper heat treatment of the iron, and points to the necessity of more detailed and extensive study of this question.

Model Experiments and Speed Trials of 60-foot Motor Cruiser Kathmar II

BY A. E. LUDERS

Abstract

Having been able to make a great deal of use of the various papers on the subject of resistance of ships and models read before this society, it has occurred to the writer that possibly similar data of a type of vessel that has not been touched upon in previous papers may prove of interest.

For this purpose the owner, Robert T. Fowler, Esq., of the 60-foot gasoline (petrol) cruiser *Kathmar II*, kindly placed this boat at my disposal, and a number of runs, results of which are plotted on a curve sheet, were made. To supplement this practical information the Navy Department most courteously agreed to make and test a model of this boat under similar conditions of draft—their interest making this paper possible.

The results of the model experiments as made by them are given on the same sheet as the other information.

The trials were over the New York Yacht Club course, 1.1 knots at Hempstead Bay, where four double runs were made.

Kathmar II was launched in the spring of 1911, at which time she floated—in light cruising trim—at her designed load water line. The difference of displacement on the 1913 trials is accounted for by the boat being deeply laden, preparatory to starting on an extended course, by soakage and the gradual augmenting of equipment, etc., that occurs from season to season.

The bottom of this boat had not been painted for three weeks, and was undoubtedly soft, though not foul. This probably explains somewhat the increase in horsepower over model experiments by an amount that indicates that the actual skin friction was practically double the theoretical.

The increased horsepower required to drive the boat with the stern cut off square at the waterline was unexpected.

The effective horsepower from trial was deduced from the thrust of the propeller (the wheel being deeply immersed, only 3 percent of wake was assumed), and using results of Prof. Durand's investigation (Vol. ——) as a basis from which to work by the laws of comparison of similar propellers. On the basis of a propulsive coefficient of 65 percent the horsepower at the 10.26-knot point agrees well with the brake test of the motor.

In general, the design of *Kathmar II* proved very satisfactory in seaworthiness and stability, and was somewhat faster than similar boats of the same power.

Some Graphic Studies of the Active Gyro Stabilizer

BY ELMER A. SPERRY

Abstract

This work was undertaken to verify some observations made in connection with the sea trials of the active gyro stabilizer, which time did not permit of reproducing, and also to pursue some investigations further than was possible at sea, where it was felt that the sea characteristics were only at best roughly estimated, and where, for purposes of checking, their recurrence could not be secured. Again, a number of questions arose upon which more light was needed as to the exact behavior of the active gyro stabilizer; for instance, under widely varying phase relations of sea and ship, and also under widely varying conditions as to wave slope, general sea intensity, etc. In this way we have been enabled to verify, under conditions of much more extended observation, just what happens when the stabilizing capacity of the gyros is approached, exceeded and also far surpassed, and thus verify the results at sea.

Another important point is that with the new stabilizer no special problems whatever are introduced by the condition of synchronism or, in fact, any harmonic relation between the periods of the sea and ship.

Again, no small interest centers about the fact that with the active stabilizer no phenomena exist corresponding to the marked falling off in stabilizing capacity of damping tanks each side of the synchronous condition, nor in any phase relation possible between the waves and ship at which the active stabilizer is found to have the slightest tendency to add anything whatever to either the amplitude or the persistence of roll as do tanks.

It has been ascertained, also, that no alterations or adjustments of the gyro are necessary to fit changes in period of either sea or ship. The plant was found to work with equal reliability throughout the whole gamut of phase relation of wave slope and also under conditions of forced rolling.

Under the head of "Forced Rolling," that is, when the ship leaves her natural period and takes up the period of the sea, it is believed that never before has this interesting phenomena been studied where, for all practical purposes, the ship has been completely stabilized for all frequencies, and it is believed that an advance has been made in knowledge of forced rolling, and the conditions under which it invariably takes place.

The stabilizing efficiencies of the active model have been determined, confirming the high efficiencies observed in operating a full-sized plant at sea.

The unique action and dependability of the journals have also received confirmation.

The space and weight requirements, smallness of the power required, and the very low maximum stresses in the plant, as well as in the ship in the vicinity of the plant, have also received a valuable check.

The general reliability and simplicity of the system of velocity control have also received confirmation.

Electric Propulsion on the U. S. S. Jupiter.

BY W. L. R. EMMET

This paper is published on page 30.

New Canadian Pacific Liner

The quadruple screw steamer *Empress of Russia* was built at Glasgow for the Canadian Pacific Railway Company's passenger service between the American continent, Japan and China. She left Liverpool on April 1 for the Pacific on a tour round the world with a large number of passengers. The chief particulars of the ship are:

Length over all	590 feet
Length between perpendiculars	570 feet
Breadth, molded	68 feet
Depth, molded, to shelter deck	46 feet
Gross tonnage	16,800 tons
Mean draft	26 feet 9 inches
Deadweight	7,000 tons
Speed on service	20 knots

The *Empress of Russia* was built by the Fairfield Shipbuilding & Engineering Company, Govan, to Lloyds rules for shelter deck type, and is classed 100 A–1. She has four continuous decks extending for the full length of ship, and at each end there is an orlop deck. Above the shelter deck a combined forecastle and bridge deck extends to well aft of 'midships, and is carried on open supports from 'midships to the stern. Above the bridge deck there is the promenade or boat deck, which extends between the masts.

The propelling machinery consists of Parsons turbines, driving four shafts. The two inner turbines are low-pressure, the port outer is a high-pressure turbine, which exhausts into the starboard outer turbine, which is the intermediate pressure. The two inner turbines are designed for driving the ship astern.

The four turbines are arranged in one room, which extends for full width of the ship. The condensers and auxiliary machinery are placed in the auxiliary engine room just aft of the turbine room.

Steam is supplied by six double-ended and four single-ended cylindrical boilers, having a total heating surface of 54,250 square feet and a total grate surface of 1,344 square feet, designed for a working pressure of 200 pounds per square inch. The boilers are arranged in three boiler rooms, and are worked under forced draft on Howden's system.

The electrical installation consists of four turbine-driven generating sets, each of 250 kilowatts capacity, while as a stand-by in case of complete breakdown of the main plant an 18-kilowatt generating set is installed on shelter deck above the waterline.

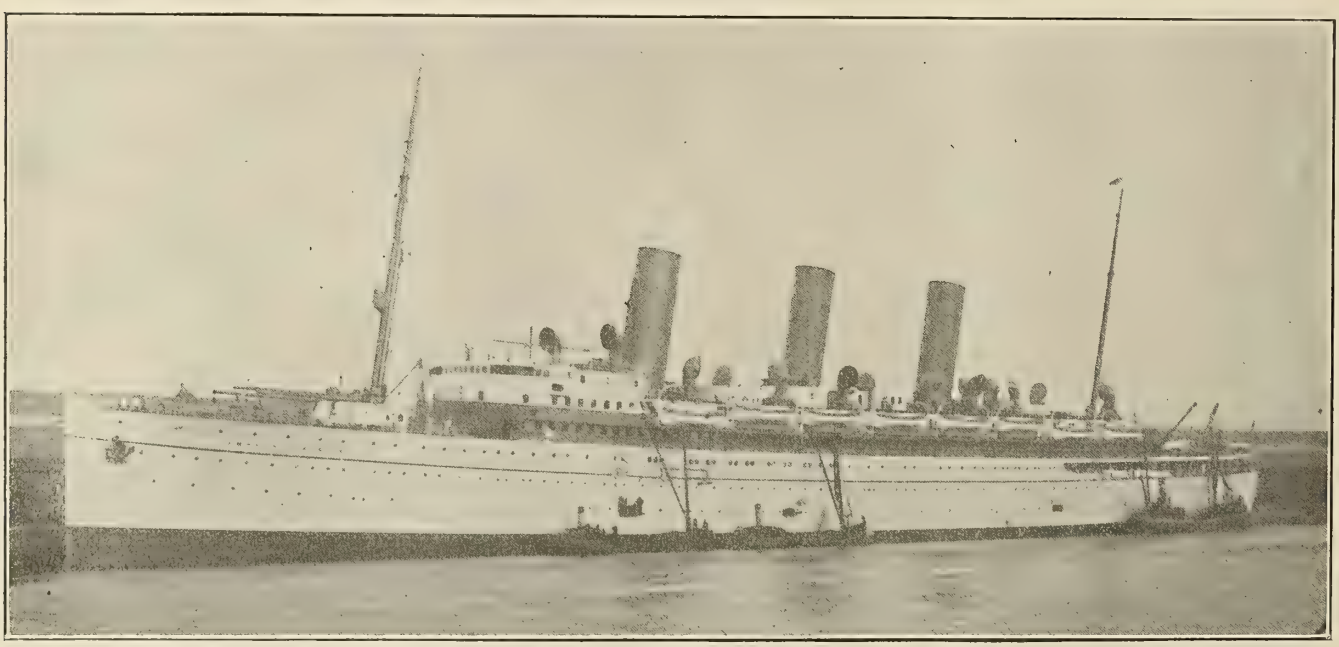
The ship is ventilated by the thermo-tank system; about twenty of these tanks are situated throughout the ship. To insure silent working the cargo cranes and winches are electrically driven. Wireless telegraphy and submarine signaling arrangements are provided.

Special attention has been given to the question of watertight subdivision, both in regard to the spacing and height of the transverse bulkheads and the provision of watertight flats, and it is claimed that the ship will remain afloat with any four adjacent compartments open to the sea. The watertight bulkheads extend generally to the shelter deck, a height of about 18 feet above the load waterline, and two of the bulkheads extend to the bridge deck. The coal bunkers are situated at the sides of the boiler rooms, and extend from the tank top to the main deck.

The *Empress of Russia* has accommodation for 200 first-class passengers, 100 second and 800 third class Asiatic passengers. The first class public rooms consist of dining saloon, library and writing room, lounge, card room, smoke room and veranda café, all of which are large and tastefully furnished. In addition there is a well-equipped gymnasium.

The *Empress of Russia* commenced her steaming trials on March 22. A series of progressive speed runs was made over the measured mile on the Clyde at speeds of from 12 to 21¼ knots. The contract required that runs up to 20½ knots should be made, and this was exceeded by ¾ knot. Following these progressive runs a further trial was carried out for a distance of 610 nautical miles. This distance was covered at an average speed of 20½ knots, which is ½ knot in excess of the contract requirements.

This is the first liner to have a straight stern like a warship, and the adoption of this type of stern has given very satisfactory results as regards speed, vibration, steering and seagoing qualities.



Quadruple Screw Steamer Empress of Russia. Equipped with Parsons Turbines, Maximum Speed on Trial 21¼ Knots

Shipbuilding in the United States in 1913

New Merchant Vessels Chiefly for Domestic Trade—Shipping for Foreign Trade Continues to be Neglected—Greatest Activity in the Atlantic Yards—Warship Construction at Navy Yards Increasing—Lake Shipbuilding Marked with Unusual Dullness

Few people realize that at the present time the American merchant marine comprises a total of 7,886,518 tons, and that it is exceeded only by the merchant marine of Great Britain, which amounts to 18,696,237 tons. Germany is third in the list, with 5,082,061 tons. Unlike the British and German merchant fleets, however, practically all of the American merchant marine is engaged in the domestic trade.

There is much deserved criticism of the American Government for doing nothing whatever to foster the building and operating of vessels in the foreign trade. The shipbuilding and ship operating business is about the only industry that not only has not received encouragment, but that has been hampered in many ways by laws that are unreasonable and unjust. Every Congress for the last fifty years has made a more or less weak effort to further the interests of the merchant marine, but at no session has there been sufficient public sentiment or concerted action to accomplish anything.

As a result, there are less than a dozen ships in the foreign trade flying the American flag, and all of these are from ten to twenty years or more old. Furthermore, it is a question whether six of these ships are not operated contrary to law, because the control of the vessel so far as ownership is concerned is in the hands of people who are not American citizens.

To get some idea of what the possibilities of the shipping and ship owning industry would be if the Government would offer reasonable encouragement it is only necessary to see what has been done for the merchant marine in the domestic trade. Recent census reports show that the capital invested in shipyards within the borders of the United States represents practically $150,000,000 (£30,800,000) and that in these yards about $100,000,000 (£20,500,000) is spent annually in wages and for materials. The American merchant marine itself, in spite of its many handicaps, has expanded along the seacoasts and on the Great Lakes and other inland waterways until it represents a total investment of approximately $600,000,000 (£123,000,000). The yearly payments for wages, salaries, etc., are about $120,000,000 (£24,600,000) and repairs and renewals of vessels represent an expenditure of about $30,000,000 (£6,150,000).

If to the total of the American merchant marine were added the 2,000,000 or more tons of vessels now in the foreign trade owned by Americans, but operating under the flags of other countries because of the handicap placed upon vessels in such trade when flying the American flag, the total American merchant marine would be increased by this amount, bringing it up to nearly 10,000,000 tons. Furthermore, there would be an increase in the amount of the capital invested in shipping already quoted of about 33 percent, with corresponding increases in wages, salaries, money spent for repairs, etc., to say nothing of the taxes that would be collected on this tonnage. As some of the vessels in question are in the passenger service and others in the freight service, a unit of $75 (£15.4) per ton can be safely adopted as a valuation. This would represent $150,000,000 (£30,800,000) of American money invested in ships at the present time flying foreign flags, and yet not benefiting the American Government to the extent of one penny so far as taxes, etc., are concerned.

The Leading Shipbuilders

With the foregoing conditions in mind, it is of interest to examine the records furnished by the American shipyards, showing the amount of shipbuilding which has been carried out during the past year. While the following figures are by no means complete, since many of the smaller shipyards have failed to furnish the necessary data required to make such a record complete, nevertheless the returns from the largest and most important shipyards in the country are complete and give a good idea of the extent of shipbuilding at the present time.

In Table I are given figures showing the number, gross tonnage and indicated horsepower of the merchant vessels built during the year by sixteen of the leading shipyards, while in Table II are given the number, displacement tonnage and indicated horsepower of naval vessels completed during the year 1913. From these tables it is evident that the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., produced the greatest volume of tonnage during the year, although the American Shipbuilding Company, comprising several yards on the Great Lakes, produced the greatest amount of merchant tonnage.

TABLE I—MERCHANT CONSTRUCTION

	No.	Gross Tons.	I. H. P.
American Shipbuilding Company	16	57,769*	31,740
Newport News Shipbuilding and Dry Dock Company	7	35,873	22,550
New York Shipbuilding Company	15	35,204	20,300
Maryland Steel Company	7	25,793	17,000
Wm. Cramp & Sons Ship and Engine Building Company	4	22,800	11,400
Harlan & Hollingsworth Corporation	9	13,747	14,760
American Car & Foundry Corporation	17	10,400	......
Fore River Shipbuilding Corporation	9	10,315*	6,150
Great Lakes Engineering Works	12	9,888*	7,260
Ellicott Machine Corporation	7	4,000	......
Union Iron Works	5	3,766	2,656
Manitowoc Shipbuilding and Dry Dock Company	6	2,778*	1,150
Seattle Construction and Dry Dock Company	4	2,642	8,070
Staten Island Shipbuilding Company	6	2,640	4,250
United Engineering Works	4	1,870	5,485
Bath Iron Works	1	306	275

TABLE II—NAVAL CONSTRUCTION

	No.	Tons Displacem't.	I. H. P.
Newport News Shipbuilding and Dry Dock Company	2	38,160	13,400
Maryland Steel Company	1	19,250	7,000
Mare Island Navy Yard	1	19,230	6,300
Bath Iron Works	2	2,040	32,000
Wm. Cramp & Sons' Ship and Engine Building Company	2	2,020	32,000
Seattle Construction and Dry Dock Company	1	1,838	1,600
Fore River Shipbuilding Corporation	1	1,010	16,000

Shipbuilding Work at Navy Yards

In addition to the naval work in progress and under contract at the private shipbuilding establishments, two of the navy yards—the one at New York and the one at Mare Island, which are the only navy yards equipped for shipbuilding—are engaged with work to their maximum capacity. In fact, there is now a greater volume of new shipbuilding work in progress and authorized at these navy yards than ever before in the history of the new navy. At the New York yard the battleships *New York* and *No.* 30 are under construction, and at the Mare Island yard the river gunboats *Monocacy* and *Palos* and the fuel ships *Kanawha* and *Maumee* are under construction, while the electrically-propelled collier *Jupiter* has only just been completed.

Work in the Atlantic Yards

On the whole, the yards on the Atlantic coast have had a busy year, although the actual capacity of the yards is considerably greater than the amount of tonnage produced. At the

* Tonnage of non-propelled vessels not reported.

Newport News yard, which is credited with first place, a number of large vessels were built, including the two naval colliers, *Proteus* and *Nereus*, of 19,250 tons displacement and 7,000 horsepower each; the Clyde liner *Lenape* of 5,179 gross tons and 3,600 horsepower; the Matson Navigation Company's passenger and freight ships, *Matsonia*, of 9,729 gross tons, 8,500 horsepower, and *Manoa*, of 6,850 gross tons and 4,000 horsepower. Other large freighters built included two bulk oil carriers, the *Illinois*, of 5,225 gross tons and 2,800 horsepower for the Texas Company, and the *Topila*, of 5,125 gross tons and 2,350 horsepower for the Southern Pacific Company. The freight steamer *L. K. Thurlow*, of 3,178 gross tons, 1,300 horsepower for the Crowell & Thurlow Steamship Company, and the bulk oil barge *Tamesi*, of 632 gross tons for the Southern Pacific Company, complete the list of vessels built at this yard during the year.

In addition to the above, a large amount of work is now in hand at the Newport News yard, including the battleships *Texas*, of 26,250 tons, and the *Pennsylvania*, of 31,400 tons. The Mallory freighters, *Meches* and *Medina*, each 420 feet 9 inches long by 54 feet 3 inches beam and 33 feet 9 inches depth, fitted with triple expansion engines of 4,100 horsepower; two large bulk oil steamers for the Standard Oil Company, each of which is about 475 feet long; an oil barge for the navy is also under construction and the freight and passenger steamship *Carolina* of the New York and Porto Rico Steamship Company is at the yard for remodeling of the hull and the installation of new machinery.

The New York Shipbuilding Company, which turned out practically the same amount of merchant tonnage as the Newport News yard, delivered during the year the passenger and freight steamer *Congress*, 7,985 gross tons, 7,000 horsepower, for the Pacific Coast Steamship Company; the Hudson River Day Line steamer *Washington Irving*, 3,104 gross tons, 6,000 horsepower; two bulk oil steamers for the Standard Oil Company, each of 3,663 gross tons and 1,900 horsepower, and a collier of 3,521 gross tons and 1,750 horsepower for the Coastwise Steamship Company. Other important vessels include the Old Dominion Company's freight steamer *Tyler*, of 3,928 gross tons, 1,750 horsepower, and the ferryboat *Santa Clara*, of 2,000 gross tons, which was built and shipped in knock-down form to the Southern Pacific Company. In addition to the above steam-driven vessels, eight car floats, ranging from 800 to 1,015 gross tons each, were delivered to various railroads.

The work now in hand at the yards of the New York Shipbuilding Company includes the Argentine battleship *Moreno*, 27,650 tons; the Chinese cruiser *Fei Hung*, 2,600 tons; the U. S. battleship *Oklahoma*, 27,500 tons, and four destroyers of over 1,000 tons each, besides the destroyer tender *Melville*, of 7,150 gross tons and 4,670 horsepower. The merchant vessels now under construction at this yard include the collier *Hampden*, of 4,727 gross tons, 2,100 horsepower, for the Coastwise Steamship Company; the ferryboat *Mayor Gaynor*, 1,075 gross tons, 1,950 horsepower, for the city of New York, and four car floats.

Although the Maryland Steel Company, which is the next yard on the list as regards the volume of merchant tonnage completed in 1913, does not usually undertake naval construction, nevertheless during the past year it delivered one naval collier, the *Jason*, of 19,250 tons displacement and 7,000 horsepower. The largest merchant vessels delivered from this yard were three freight steamers for the American-Hawaiian Steamship Company, each of which was of 14,495 tons displacement, 6,649 gross tons and 4,000 indicated horsepower. Two other interesting passenger and freight steamers, the *City of Annapolis* and *City of Richmond*, which are described in this issue, were built during the year for the Chesapeake Steamship Company. In addition to the above steam-driven vessels, two steel barges of 1,000 gross tons each were built for the Isthmian Canal Commission.

Three other freight steamers for the American-Hawaiian Steamship Company, sister ships to the vessels delivered in 1913, are now under construction by the Maryland Steel Company. This company also has in hand four more barges for the Isthmian Canal Commission, besides two railroad lighters and a tug. During the past year the Maryland Steel Company also installed in the Merchants and Miners steamship *Cretan* four Scotch boilers, 13 feet 6 inches diameter and 11 feet long.

Four freight steamers, three of which were of 6,000 gross tons and 3,000 indicated horsepower, and one 4,800 gross tons and 2,400 indicated horsepower, all for W. R. Grace & Company of New York, comprise the bulk of tonnage turned out last year by William Cramp & Sons' Ship and Engine Building Company, Philadelphia. Ten coal barges of 500 tons coal capacity each were built for the United States Government and the naval work included two destroyers, the *Aylwin* and *Parker*, of 1,010 tons displacement and 16,000 horsepower, both of which were equipped with Cramp turbines. Seven other destroyers, five equipped with Cramp turbines, and two with Parsons turbines, are now under construction at this yard, as well as the naval gunboat *Sacramento* and the submarine *G*-4, which will be delivered about the first of the year. Two freight and passenger express steamers, 524 feet long, 63 feet beam, 50 feet 6 inches depth to A-deck, of 10,000 tons displacement and 23,000 indicated horsepower, fitted with Parsons turbines, are now under construction as well as a car ferry, 350 feet long, for the Florida East Coast Railway Company.

The Harlan & Hollingsworth Corporation, Wilmington, Del., which does merchant work only, delivered during the year the Sound steamers *Narragansett* and *Manhattan* for the Central Vermont Transportation Company. These boats are of 3,540 gross tons, equipped with triple expansion engines developing 4,800 indicated horsepower. The ferryboat *Bayonne*, of 1,235 gross tons and 1,500 indicated horsepower, for service in New York harbor, and the ferryboats *Salem* and *Bridgeton*, of 774 gross tons and 700 indicated horsepower, both for service in Philadelphia harbor, were built at this yard, besides four car floats of over 800 gross tons each. In addition to the vessels, engines amounting to 2,360 indicated horsepower were built for hulls constructed elsewhere. The work now under construction at this yard for future delivery includes another ferryboat for Philadelphia and a sidewheel excursion steamer for service on Lake Pontchartrain. The gross tonnage of the latter is estimated at 700 and the indicated horsepower of the engines 600.

Boiler work forms an important part of the business carried on by the Harlan & Hollingsworth Corporation, and during the year 1913 no less than 24 boilers, aggregating 10,729 horsepower, were delivered and at present there are under construction for delivery in 1914 fourteen boilers, aggregating 6,393 horsepower.

In the Delaware district the American Car and Foundry Company, Wilmington, built a large number of small craft, including car floats, barges, scows and steamers, the approximate gross tonnage of which totaled about 10,400 tons. This company now has under construction four sea-going lumber barges, each 200 feet long, five car floats, each 250 feet long, and a dump scow, 144 feet long, the total approximate gross tonnage of these vessels aggregating about 8,050 tons.

Three steam trawlers 120 feet 6 inches by 22 feet 6 inches, of 253 tons gross and 450 indicated horsepower, were delivered in 1913 by the Fore River Shipbuilding Corporation, in addition to an oil tanker of 6,563 gross tons and 3,000 horsepower, and a bulk cargo steamer of 2,993 gross tons and 1,800 horsepower. Four car floats, each 340 feet by 38 feet, completed the amount of merchant work delivered from this yard during 1913. One naval vessel, the destroyer *Duncan*, 1,010 tons displacement and 16,000 horsepower, equipped with two Curtis turbines, was completed, and there are in hand the Argentine

battleship *Rivadavia,* 27,600 tons displacement, 39,000 indicated horsepower; the battleship *Nevada,* 27,500 tons displacement, 26,500 horsepower; nine submarines and the submarine tender *Fulton,* 216 feet by 35 feet, equipped with a Nlesco six-cylinder engine of 900 horsepower, and two destroyers. All of the naval vessels under construction in this yard are to be equipped with Curtis turbines with the exception of the submarines and the submarine tender, where Diesel engines, supplied by the New London Ship and Engine Company, are to be installed. The freight steamers *Atlantic* and *Pacific,* of 5,500 gross tons and 2,100 indicated horsepower each, and the tank steamer *Amolco,* of 2,500 tons gross and 1,300 indicated horsepower, are under construction.

The Ellicott Machine Corporation, of Baltimore, built three pipe line steel hull dredges of about 900 tons each, one pipe line steel dredge of about 500 tons, one wooden hull pipe line dredge of about 300 tons, and two steel derrick lighters of about 250 tons each. This firm now has under construction two steel hull pipe line dredges of about 900 tons each, and a sea-going hopper dredge of about 1,000 tons.

Work at the Staten Island Shipbuilding Company completed in 1913 consisted of a 1,000-ton steel barge for the Standard Oil Company and five tugs, two of which were for the Standard Oil Company, one for the Texas Steamship Company, one for the Hamburg-American Line and one for the Hilton-Dodge Lumber Company. These tugs range in size from 173 to 452 gross tons and from 600 to 1,100 indicated horsepower. A United States torpedo testing barge of 615 gross tons was also built for the Navy Department during the year. This company has now in hand two railroad tugs and a large amount of boiler work. No less than fourteen boilers of various types are reported from this yard.

At the Bath Iron Works, Bath, Me., where most of the work done is for the United States Navy, two destroyers of 1,020 tons displacement and 16,000 horsepower, equipped with Parsons turbines, were completed in 1913, and two other destroyers, one of which is to be equipped with Parsons geared turbines, arranged on two shafts, are now under construction. During the last year the inland lake passenger and cargo steamer *Katahdin,* 115 feet long over all, 29 feet beam, 9 feet depth and 306 tons gross, fitted with a compound engine of 275 indicated horsepower, was delivered to the Coburn Steamship Company and an order has just been received for the construction of a cup defender for the 1914 America cup races.

At some of the smaller yards a considerable amount of tonnage was produced in the form of small vessels of various types. The Skinner Shipbuilding and Dry Dock Company, of Baltimore, built two tugs and did some boiler and engine work for other tugs and steamships.

The Spedden Shipbuilding Company, Baltimore, built the fireboat *Cataract* for the city of Baltimore. William E. Woodall & Company, of Baltimore, completed a car float of 684 tons for the Baltimore and Ohio Railroad Company, and now have under construction a sea-going barge of about 1,200 tons for P. Dougherty & Company, of Baltimore. At the plant of the E. J. Codd Company, Baltimore, the marine work consisted chiefly of engine and boiler work, two compound engines and three boilers having been completed.

In the New England district the G. G. Deering Company, Bath, Me., built the five-masted schooner *Courtney C. Houck,* 218 feet 9 inches long, 42 feet 7 inches beam and 24 feet 6 inches depth. This vessel has a gross tonnage of 1,627, a net tonnage of 1,357 and a cargo-carrying capacity of 2,500 tons. The Portland Company, Portland, Me., built two fishing steamers, one 150 feet long overall, equipped with a 450 horsepower engine, and the other 185 feet long overall, equipped with a 900 horsepower engine, and the towboat *Charles P. Greenough,* which was described in the last issue of International Marine Engineering. A 250 horsepower towboat engine was also built by them. The Portland Shipbuilding Company, Portland, Me., has under construction a barge of 250 gross tons and a steamer of 233 gross tons, fitted with a 450 horsepower triple-expansion engine.

One of the largest Western river boat builders is the firm of James Rees & Sons, of Pittsburg, who built last year two boats for South American service, one of 150 tons and the other 300 tons. The work now in hand at this yard includes two shallow draft vessels of 150 tons each, while a considerable amount of additional boiler work has been done during the past year and is now in hand for early delivery.

Shipbuilding on the Lakes

The past year in lake shipbuilding has been marked with unusual dullness, which is reflected by the comparatively small number of ships built. General repair and drydock work, however, has kept the yards fairly busy until the early part of November, when the disastrous storm swept the lakes, and since then, owing to the unusually large amount of damage sustained by a number of lake vessels, a large amount of repair work has been required. This work, together with considerable hull reconstruction and several large re-boilering jobs, has improved the prospects for the winter in general repair work, and the unusual number of total losses in the fall of 1913 has brought out a number of inquiries for figures upon new tonnage, some of which has been contracted for.

Notable among the ships built on the Great Lakes during the year 1913 may be mentioned the passenger steamers *See and Bee, North American* and *Noronic.* The first two ships have been fully described in previous issues of International Marine Engineering, and a more complete description of the steamer *Noronic* will appear in a later issue. This ship was built for the Northern Navigation Company for the run from Sarnia to Duluth by the Western Dry Dock and Shipbuilding Company, of Port Arthur. Her principal dimensions are: Length over all, 388 feet; length of keel, 363 feet; beam, 53 feet; depth, 38 feet 9 inches. The boiler plant consists of four main boilers, 15 feet 6 inches diameter by 11 feet long, built for 200 pounds working pressure and one donkey boiler, 12 feet 6 inches diameter by 11 feet long. The main engine is a four-cylinder triple-expansion engine, 29½, 47½, 58 and 58 inches by 42 inches stroke.

Among the freight vessels constructed during the year the prevailing type was for the bulk freight trade and one of these ships, the *James Carruthers,* the largest vessel built in Canada to date, was lost with her entire crew in the storm on Nov. 9.

The coming year shows no sign at present of being an unusually active one in lake shipbuilding, but it should prove up to the general average commensurate with conditions throughout the country, which, of course, are always reflected in this as well as the other industries.

Of the lake shipbuilding firms, the American Shipbuilding Company produced the greatest amount of tonnage, and, as before noted, this firm holds the record for building the largest amount of merchant tonnage in the country. Four sister ships of the bulk freight type, 600 feet long, 58 feet beam and 32 feet depth, with a tonnage of 7,705 and an indicated horsepower of 1,880 each, were built for the Pittsburg Steamship Company. The bulk freighter, *Alton C. Dustin,* with a tonnage of 7,978 and an indicated horsepower of 1,750, was built for the Franklin Steamship Company. Two bulk freighters of 1,706 tons and 900 indicated horsepower were delivered to the George Hall Coal Company and three oil tank steamers of 2,486 tons and 1,650 indicated horsepower each and three oil tank barges of 2,441 tons each, were built for the Standard Oil Company. Two notable passenger and freight steamers, the *See and Bee* and *Noronic,* which have already been noted, form a part of the output of this concern, while the remaining vessels included a packet freight steamer of 2,326 tons and 900 indicated horsepower for the Canadian Interlake Line,

Ltd., and a stern wheel passenger and freight steamer for the Canadian Pacific Railroad.

The next largest producer on the lakes was the Great Lakes Engineering Works, where the steel packet freight steamer *Boston*, of 4,184 tons and 1,760 indicated horsepower, was built for the Western Transit Company, the passenger steamer *North American*, of 2,317 tons and 2,000 indicated horsepower, for the Chicago, Duluth and Georgian Bay Transit Company, and a steel car ferry of 2,670 tons and 2,500 indicated horsepower for the Grand Rapids and North Western Railroad. Four of the producer gas coal barges for the Alabama and New Orleans Transit Company were finished during the year, while construction on nine similar barges for this company is rapidly progressing. The output of the Great Lakes Engineering Works also included the hulls for two dredges, a steel grain lighter and a steel flat lighter.

At the Manitowoc Shipbuilding and Dry Dock Company three dredges of different types, one a dipper, the second a suction and the third a hydraulic dredge, were built, besides two car floats and a tug for the Erie Railroad, described in a previous issue of INTERNATIONAL MAGINE ENGINEERING.

At the Toledo Shipbuilding Company, the ferry *Essex*, 105 feet long, propelled by a 500 horsepower inverted high-pressure engine, was built for the Detroit and Walkerville Ferry Company.

Three of the Canadian yards, the Collingwood Shipbuilding Company, the Kingston Shipbuilding Company and the Polson Iron Works, completed several smaller vessels of miscellaneous types, including dredges, scows and a passenger and freight steamer. As previously noted, the first of these firms built the large freighter *James Carruthers*, which was lost in the November storm.

PACIFIC COAST YARDS

On the Pacific Coast the principal yards have in hand a considerable amount of naval work, although only a few naval vessels were completed in 1913. At the Union Iron Works two submarines were delivered, while the merchant vessels built at this yard consisted of two lumber carriers, one of 1,600 gross tons and 1,358 indicated horsepower, and the other of 1,456 gross tons and 1,178 indicated horsepower, an oil tanker and an oil barge for the Standard Oil Company, and an oil barge for W. D. Ayers. The Union Iron Works now has under construction a large oil tanker for the Associated Oil Company, which will have a tonnage of 6,430 and an indicated horsepower of 2,400.

At the Seattle Construction and Dry Dock Company's yard the year's production was varied, including two submarine boats, one for the Chilian Government and the other for the United States Government. The other government work completed consisted of nine steel coal barges and the suction dredge *Colonel P. S. Michie*, of 1,838 gross tons and 1,600 indicated horsepower, for the United States Government. Of special interest in the merchant work produced in this yard during the year were the day passenger steamer *Tacoma*, of 836 gross tons and 3,760 indicated horsepower, built for the Inland Navigation Company, and equipped with Ballin water-tube boilers and four-cylinder triple-expansion engines; the steam yacht *Cyprus*, of 1,037 gross tons and 3,000 horsepower; the cargo steamer *Comanche* and a tug for the Milwaukee Terminal Railroad Company.

The work now in hand at the Seattle Construction and Dry Dock plant consists wholly of government work, including three tugboats, one submarine and the submarine tender *Bushnell*, for the United States Government, and a submarine for the Chilian Government. The submarine tender *Bushnell*, by the way, is to be fitted with geared turbines and Yarrow boilers.

Four vessels aggregating 1,870 gross tons and 1,430 indicated horsepower were turned out by the United Engineering Works, while machinery for vessels other than those built by this company was delivered, aggregating 4,055 horsepower.

Other vessels built on the Pacific Coast include the fast ferryboat *Edward T. Jeffery*, which the Moore & Scott Iron Works built for the Western Pacific Railroad, and the side-wheel ferry *Leschi*, of 477 gross tons and 700 indicated horsepower, which J. F. Duthie & Company, of Seattle, built for the Port Commission of Seattle.

ANNUAL REPORT OF THE SECRETARY OF THE NAVY.—In his annual report for the fiscal year 1913, the Secretary of the Navy recommends the authorization by the present Congress of two dreadnoughts, eight destroyers and three submarines as the building program for 1915. This is contrary to the recommendations of the General Board, which proposed the construction of four battleships, sixteen destroyers and one destroyer tender, eight submarines and one submarine tender, two oilers, two gunboats, one transport, one supply ship and one hospital ship. The Secretary further states that the time has come when the department should be freed from excessive prices charged by private manufacturers of armor plate, guns and gun forgings, powder, torpedoes and other supplies and munitions, and he recommends that provisions be made for an armor plate factory, and an increase in the gun factory, the powder factory and the torpedo works. At present there are only three firms in America which can manufacture armor plate and bids for armor plate from these firms seldom vary over a few dollars, being in every case an excessive price. The Secretary maintains that the Government can achieve a saving by the erection of a 10,000-ton-a-year plant of $1,061,360 (£217,500) per annum after deducting 4 percent as interest on the money used in erection and installation of the plant, and $3,048,462 (£625,000) a year on the basis of a Government plant capable of producing 20,000 tons a year. The Secretary further recommends to Congress the consideration of providing fuel oil for the navy at reasonable rates and the passage of legislation that will enable the department to refine its own oil from its own oil wells and thus relieve itself of the necessity of purchasing what seems fair to become the principal fuel of the navy in the future at exorbitant and ever-increasing prices from the private companies that now practically control the supply. While at present only a portion of the United States Navy is equipped to burn oil, nevertheless the navy is using this year 30,000,000 gallons of oil, and there is every likelihood that this amount will be increased to 125,000,000 gallons in the future. Every gallon of this must be purchased from the oil companies at their own prices until Congress relieves the department by proper legislation.

ANNUAL REPORT OF THE UNITED STATES REVENUE CUTTER SERVICE.—Summarizing the lengthy annual report of the United States Revenue Cutter Service, E. P. Bertholf, captain commandant, states: "The winter season of 1912-13 was of unusual mildness compared with the severe weather of the previous winter, but the occurrence of several gales along the coast, together with accidents to ships from other causes, called forth the usual vigilance and activity of the fleet of revenue cutters and the result of these operations of the service during the past fiscal year shows that $10,626,610 (£2,180,000) worth of property has been saved from the perils of the sea and that there have been 327 lives saved or persons rescued from danger. As the total cost for the maintenance of the service during that period was $2,471,532.51 (£507,500), the year's efforts produced a consummation of $4.29 (17/11) for each dollar thus invested by the Government. Twenty-five cruising cutters and 18 harbor vessels and launches were actively employed in the service during the year.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdown at Sea and Repairs

A Stranded Engineer Repairs a Crippled Engine

When I used to go to school, and that's a long time ago, the teacher told us boys that if he took a tub of water and dropped a lot of little chips all around on the surface, pretty soon they would all be sticking to the sides of the tub or gathering in little clumps. He called this "capillary" attraction, and I used to amuse myself trying it, always finding that it was so, which rather goes to prove that I didn't always believe what my teacher said.

There are a whole lot of men that are floating around in this tub of a world, especially that part of it in which I have knocked about—the West Indies—and you find some of them sticking along the edges of the Spanish Main and Gulf and in little groups on various islands. I have been one of these floaters, and once upon a time I found myself flat broke, down to 60 cents (2/6), on the coast in a little village where there was nothing for me to do and no way that I could see of getting out of the place.

But luck, as we call it, came to my aid, and when I had reached the 60-cent (2/6) condition a little steamer dropped anchor off shore, and the captain came in to look after a cargo of bananas that he was to pick up there. I kept my eye on him and as soon as he landed he struck trouble.

He couldn't speak Spanish, and the two darkies that rowed him ashore spoke only French, and such French! There was my chance. When he began to "holler" in English I knew he couldn't speak Spanish, and it's a queer thing that people seem to think that if they "holler" loud enough in English any foreigner will understand them, and when that doesn't work they start in with broken English or baby talk.

Well, I got hold of the captain; and as I spoke Spanish, I got him out of his troubles, and all the time I was helping him I was wondering how I could get a job aboard his tub of a boat. But he helped me out by asking me if I knew anything about machinery, and when I told him I was an engineer he almost fell on my neck. His boat flew the flag of a country that didn't have any Board of Supervising Inspectors or any laws that I ever heard of about safety at sea, so he only had one engineer, and he was sick, and there was trouble with the engine. We struck a bargain at $100 (20/16/8) a month, or any part of it, and in half an hour I was on board. The engineer was sick and there was nobody to look after him. I started the cook making some good soup for him out of turtle meat, and I made him some hot tea, until he was able to tell me that the engine, on account of his illness, had been run by the oilers, and was in very bad shape.

I went below and looked over the engine. The only serious trouble seemed to be in the high-pressure valve-stem head. This was forged on the valve stem, as shown in my sketch, Fig. 1. The eyes in the two lugs were worn by the link block pins, so there was half an inch play on one side and one-eighth of an inch play on the other. In fact, one of the lugs was almost worn through. The holes in these lugs had originally been bushed, but where the bushing had gone I couldn't find out.

There were no tools aboard the boat of any kind beyond a ratchet and a few drills and a grindstone, which had no frame, and you could only wear off a drill by rubbing it on the side of the stone as it lay on one of the benches. I got the valve stem out, and luckily discovered in a drawer a hack-saw and several new blades. I hunted around and found a piece of boiler iron about eleven-sixteenths thick, and this is how I fitted up the same:

First, I hack-sawed off the two lugs, leaving the head as shown in Fig. 2. I had, fortunately, found a number of files which belonged to the chief personally. I filed up the two sides of the valve-stem head and laid it one side. Then, after a long hunt, I came across four good cold chisels, also the property of the chief.

Out of the eleven-sixteenths steel I made two lugs, as in Fig. 3, which, of course, were to a certain extent like those I had cut off from the valve-stem head. The vise which was on board the boat was in pretty good condition, and with it and my files I worked out these two lugs as shown. The recesses

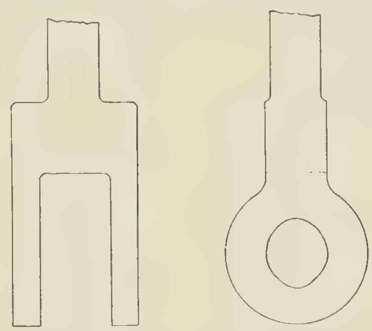


Fig. 1

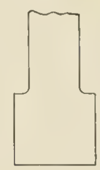


Fig. 2

Fig. 3

I fitted with a good deal of care to the valve-stem head. When I got these fitted so they would drive on with a piece of lead I started to hunt up some tool steel to make a small drill to drill a hole through the lugs in the head to hold them in position.

But here I was stuck. First, because there was not a piece of tool steel aboard of any kind except my files; second, I had nothing that I could use for drilling a small hole. But, mussing around, I found a piece of tubing, probably one of the boiler tubes, and by filing off the corners of the lugs I could force this piece of boiler tube down over them, forming a sort of collar, and thus hold them firmly in position. I was afraid this might work off, so I wired the collar to the head by passing a wire underneath the head and up over the sides of the collar and down, twisting the ends together.

Next I poured babbitt into the four openings made by the collar around the head and lugs. When this was cool I found I had a pretty firm job, and now the question was to get the holes in these lugs true and of a size to fit the pin in the link block. The parts of this pin against which the lugs of the valve stem had worked were considerably worn, but more battered. I dressed the pin all up carefully with a file, and then I was in trouble for some bushings.

There wasn't a piece of brass or composition aboard the ship that I could find except some sheet metal about a good sixteenth of an inch thick. After thinking the matter over I made up my mind I could use this sheet brass, but first I had to get the holes in the lugs. If I remember rightly the link-block pin was about one and a quarter inches in diameter. I found an inch and seven-eighths twist drill, and rubbing it upon the grindstone the best I could I started in to rig up to drill the two holes in the lugs.

The ratchet drill was in good shape, and I took the valve

stem to the top of the engine cylinders where I could get a true surface, and after a good deal of trouble I got the valve stem strapped down true and an "old man" rigged up by slacking off some of the nuts on the cylinder studs, and so making fast its foot, and without much difficulty I got moderately straight holes through the lugs.

Now to make the bushings, I cut strips of the sixteenth metal as wide as the length of the block pins. I curled this strip up until I had enough metal to be sure to fill the holes in the lugs of the valve stem, and with a hole in the middle small enough to allow filing it out to fit the link-block pins. I soldered these two rolls of metal, as I found plenty of solder on board and some acid, and with a whole lot of work with a file I made something like a fit on the link-block pin and a very good fit on the outsides of the bushes in the holes of the lugs. I put the valve stem in position, and with a little more tinkering I got everything in position and felt pretty well satisfied.

This work had taken considerable time; in fact, it took me the best part of three days, during which time the chief, under my care, was doing better, and he told me about how fast the vessels could be driven. I figured out that my spiral bushings, if I kept them cool, would probably last out until we got into some port where a proper job could be made of the work. We got away the following day, and by keeping one of the oilers constantly on the watch, we made our port without any mishap, much to my relief; but when I went to the captain to go ashore and get material and have some bushes made, there was "nothing doing."

We would have to get out at once, and he thought the repairs would last out. He was right, and a week after we dropped anchor over at Jackmel, and I was ready to quit; mostly because, after looking over the boiler, I made up my mind that as both the oilers and firemen were Haytian darkies, I would certainly become pretty well mixed up with them when the boiler let go, which it was sure to do before long.

So I got the chief ashore, and in a few days we both took steamer to Kingston, and there I am now, and I suppose that I shall always be floating around this part of the world unless this "capillary" affair draws me back home.

Kingston, Jamaica, W. I. Breakdown Johnny.

The Value of Trade Literature

I have written to and received catalogues and other literature from 43 percent of the advertisers in International Marine Engineering. Most all of the material which came to me was of considerable interest and value to me in my vocation as an instructor in steam and marine engineering, and that material is on file. In these days, catalogues, circulars, etc.—particularly those pertaining to engineering matters—*are of as much value as are text-books,* and in some instances more.

In my opinion the difference between text-books and first class catalogues is this: Text-books deal in, and treat of, elements and principles *in the abstract,* while catalogues deal in and treat of *concrete applications* of elements and principles to a given product. I am not undervaluing in the least text-books; they have an important place in the educational world. But none the less important are trade catalogues in the educational world as well as in the world of commerce.

No engineer or other person at all interested in the products of the various advertisers in International Marine Engineering can afford to ignore either the advertisements which appear from time to time, or the catalogues which are proffered the readers, whether or not they are prospective purchasers. No wise engineer does ignore them. No person can quite keep up to date, or down to date—whichever way we may say it—*unless he reads the ads. regularly and studies the catalogues and other literature* to be obtained. *Text-books alone will not keep us up to date* and cannot be expected to do so in the very nature of things. Catalogues can and do keep their readers well posted, and from all viewpoints I do not know just how we would get on without them. While I have quite a few text-books, and prize them, *I have a great many more catalogues because I need them.* This is not because they can be obtained for the asking, but because they are *really more useful* than are text-books, *after one has learned abstract elements and principles,* which do not change, but whose *applications* are almost continually changing.

Scranton, Pa. Charles Mason.

Wentworth Engine vs. the Hot Tube Type

On page 173 of the April number of International Marine Engineering was published a criticism of my engine which was of a nature hard to ignore. Mr. J. Barraja-Frauenfelder is the critic and his statement is generally incorrect. His statement divides into two parts:

1. He says my engine or the matter of preheat is not new.
2. He asks for more facts about the engine.

In my connections with the engineering profession for the last few years on this line of work I have found the attitude of Mr. Frauenfelder to be quite a common one; that is, to make authoritative such statements as are needed to support a certain argument and to deny arguments to support the opposite side of the question. This particular part of my present statement may not be very interesting to Mr. Frauenfelder, but I think that it may to other readers.

In the days of the first Diesel Engine Company of America the engineer-in-chief abruptly, positively and without the possibility of contradiction told me "That the exhaust of the Diesel was cold." The engineer in charge of assembling and testing the engines at Providence later assured me of the same fact. This latter man was offended that I should contradict him when he was handling the engines and I was not. At this time I was working on a constant pressure type of engine and I felt that if they could prove me wrong in something they knew about there would be reason for them to doubt what I told them in my own line. I submitted proof of my statement of the temperature of the exhaust of the Diesel and was met with the statement "That the engine worked and that was all they cared about." A leading shipbuilding company in the course of an examination into my work with relation to taking out a license turned me over to an engineer. This man finally rested his argument against the engine on the basis that a steam engine could be built for $12 (2/10/0) per horsepower and my engine would cost $40 (8/6/8) per horsepower. "How could the ship owner be persuaded to pay this difference?" Investigation shows that $12 (2/10/0) per horsepower means simply the engines without boilers, etc. The statements of Mr. Frauenfelder are of the same nature as the examples given.

Preheat

This word is made up of the word heat with the Latin prefix pre, meaning before. The air in the Wentworth engine is heated before the suction stroke begins. This method I have originated. If. Mr. Frauenfelder has proof to the contrary I think that it would interest the U. S. Patent Office, which has been investigating this question for some time.

The Wentworth Engine

At full load the Wentworth engine operates on the De Rochas cycle and can start at a minute's notice so long as there is a supply of energy for starting purposes. At partial loads, say two-thirds load, the thermodynamic operation of the Wentworth engine is the operation of the full stroke of the engines which Mr. Frauenfelder calls the semi-Diesel. The clearance of the Wentworth engine will bear the same relation to the two-thirds of the total cylinder volume that the clear-

ance of the engines mentioned by my critic bears to the whole stroke of their engine cylinders. In other words you can superpose a hot tube or hot bulb type indicator card on the card from a Wentworth engine at two-thirds power, and when the hot bulb engine is exhausting the Wentworth engine will still have an expansion of the hot gases half as far again as they expanded in the hot bulb engine.

I think that this will answer my critics.

SOOT

Mr. Frauenfelder tells us that the substance which is deposited is not soot, but is "half baked particles of fuel or residual carbon." To me a rose smells as sweet under any other name. I was under the impression that his compound would be known as soot to the unlearned.

SOURCE OF PREHEAT

I think that the contention which I made years ago that the exhaust of the Diesel engine was around 1000 degrees F. has been recognized as correct. Fig. 1 is the card I used to investigate the temperatures of the Diesel engine. Owing to the fact that your subject is a perfect gas you can get your temperatures by calculation from this card. The Diesel theory was to prevent an essential increase in temperature. (I mean an increase over the compression temperature.) It was my idea that they were wrong and that they should increase the temperature as high as possible. The only reason for not increasing the pressure is purely practical. I have been recently informed by the Diesel interests in this country that this is now done. This is done by the method of feeding the fuel. The top of the card is level for an appreciable part of the stroke and the mean effective pressure is increased to, say, 125 pounds from the old pressure of 100 pounds.

In starting the all-round Wentworth engine the engine must be started on the De Rochas cycle till the exhaust pipes have become heated. As soon as they become heated the preheat needed for a reduction of compression pressure will come from the exhaust gases. If it is desired to build an engine in which the compression shall never be higher than, say, 250 pounds, then it is necessary to use an external means (a hot air furnace, for instance) to provide the needed preheat. This will be more expensive than the method used in the hot bulb type and will take just as long to start. However, in this case you will still have a choice of temperatures and in such an engine the partial load compression can be brought down to, say, 175 pounds.

The crowning glory of the old, reliable and (in these days) almost despised reciprocating steam engine lies in the fact that it always goes and the only complaint which it makes is that which Kipling so well describes through the old engineer, McAndrews. My aim has been to weld into one machine the efficiency of the De Rochas cycle and the reliability and flexibility of the steam engine. It was with this aim in view that I worked on the constant pressure type which I have abandoned for the Wentworth cycle, which allows of an economical cutoff and of a greater range of fuel injection than is possible in the De Rochas cycle.

Suppose an efficiency contest be arranged under the following points:

1. Ten for the maximum output.
2. Ten for the maximum efficiency at full load.
3. Ten for the maximum efficiency at partial loads.
4. Ten for the maximum revolutions per minute.
5. Ten for the minimum revolutions per minute.
6. Ten for rapidity of start.

All engines to have the same stroke and bore.

In Test No. 1 the Wentworth and conventional Diesel would be tied. Both using cold air to compress could consume more oil without imperfect combustion than could the hot tube engine. The two cycle would show more power for the same bore, stroke and number of working cylinders.

In Test No. 2 if all engines are of perfect design and workmanship they should be tied, except the two cycle, which is less efficient.

In Test No. 3 the Wentworth engine, owing to its increased expansion over either the Diesel or hot tube engines, should easily lead by a very evident margin.

In Test No. 4 again the engines would be on an even footing with the workmanship considered equal.

In Test No. 5 the Wentworth engine would again show up well. Assuming that both the conventional Diesel and the hot tube type are properly designed there will be no great excess of temperature at the end of compression. Now as the engine begins to slow down in speed the radiation loss at the end of compression for the conventional Diesel will increase

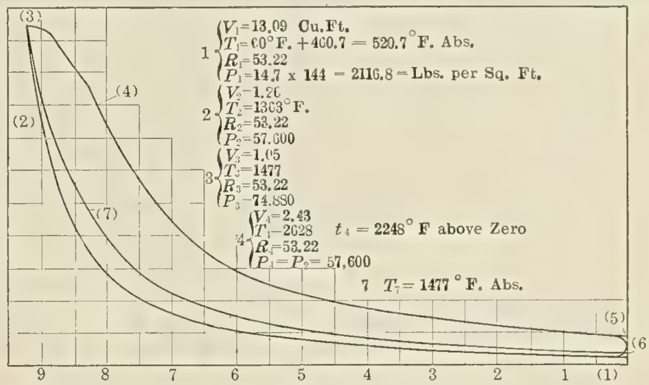


Fig. 1

till soon the temperature at the end of compression will be less than the igniting point and then the engine will stop. By means of a high preheat to the air and a retarding of the fuel injection the Wentworth engine should lead the conventional Diesel and push the hot tube type hard.

In Contest No. 6 the conventional Diesel, two cycle and the Wentworth would start without any notice, while the hot tube type must be worked over for a considerable time before it would start.

SUMMARY

Test.	Wentworth	Conventional Diesel.	Hot Tube Type.	Two Cycle Engine.
No. 1	8	8	7	10
No. 2	10	10	10	9
No. 3	10	8	8	7
No. 4	10	10	10	10
No. 5	10	8	10	8
No. 6	10	10	7	10
	—	—	—	—
Totals,	58	54	52	54

This comparison ignores the question of practicability to build a hot tube engine of large size, such as can be done with the other engines. In the 2 cycle engine the scavenging arrangement is ignored.

I trust that this clears up Mr. Frauenfelder's doubt as well as the doubts of others.

Quincy, Mass. JOHN F. WENTWORTH.

INLAND WATERWAYS.—Pleas for sufficient appropriations by Congress to complete the proposed inland waterway route along the Atlantic coast were brought forward at the annual meeting of the Atlantic Deeper Waterways Association held in Jacksonville, Fla., recently. The urgent need for the improvement of an inner trade route along the coast was emphasized and recent destructive coastal storms were pointed out as an argument in favor of the project. The need of a broad policy and of co-operation between the Federal Government and the States to secure improved waterways was also the keynote of the discussion at the National Rivers and Harbors Congress held in Washington in December. Better waterways and improved marine terminals are an urgent need in America.

Marine Articles in the Engineering Press

Thornycroft Watertube Boiler for Oil Fuel.—The latest type of Thornycroft watertube boiler, especially designed for torpedo destroyer work, embodies several novel features which have been introduced both to save weight and to increase efficiency. Oil fuel only is used, which is sprayed into the furnaces on the Thornycroft system. The heating surface on the boiler is 6,300 square feet. Both upper and lower barrels are of seamless steel and cylindrical in shape. The bottom ends of the tubes are slightly curved to allow for expansion and retain the cylindrical form of the mud drums. With the Thornycroft oil burning system the builders guarantee an equivalent evaporation of at least 16½ pounds of water from and at 212 degrees per pound of oil per hour if the rate of evaporation does not exceed 4 to 5 pounds per square foot per hour, and they further guarantee a maximum output of 16 pounds per square foot per hour from and at 212 degrees, with an evaporation of 14 pounds of water per pound of oil. 3 illustrations. 500 words.—*Engineering,* October 24.

The Fried. Krupp Germania Shipbuilding Yard, Kiel.—From a very early period in the history of German shipbuilding the Krupp metallurgical and ordnance construction works were in close connection with the shipbuilding yards, supplying ordnance and mountings, armor, crank and propeller shafts, heavy steel castings and iron and steel plates. These at first were manufactured at Essen for delivery to German yards owned by other German firms. When, however, the Essen establishments decided, in the early nineties of the last century, to manufacture basic steel on a very large scale, they placed themselves in a position to undertake also the construction of ships of all classes complete, and therefore resolved to purchase a yard for the purpose. The Germania yard had been established since 1863 and had frequently changed hands. The vessels were built at Kiel, but the engines were built at the Tegel Works, near Berlin, then owned by the Schiff und Maschinenbau A.-G. Germania, from whom Messrs. Krupp first leased and then purchased the yard. The yard was thoroughly reorganized and greatly enlarged, the entire engineering works being transferred from Tegel to Kiel. The reconstructed plant presents a very modern and splendidly equipped shipyard with the various departments thoroughly coordinated. The arrangement and equipment of some of the principal shops, such as the pattern shop, boiler shop, electric power plant and main engineering building, are described in some detail in the article. The launching ways, of which eight are provided, vary in length from 380 to 633 feet. The largest of the building slips can accommodate a battleship 820 feet long and 130 feet wide. The ways are of concrete, hollow and of rectangular shape. Their floor, which is on an incline of 1 in 18 and 23, is at their outer end at a depth of about 9 feet 6 inches below the sea level. Each slip is closed at the end which gives into the sea by a floating pontoon, an arrangement which does away with a slide beyond the ship. Four of the slips are covered over by a glazed roof carried on latticed columns, while three of the ways are open. The yard employs about 7,000 men. 13 illustrations. 3,500 words.—*Engineering,* November 7.

Royal Holland Lloyd Liner Gelria.—Messrs. Alex. Stephen & Sons, Ltd., Linthouse, have under construction for the Royal Holland Lloyd Line two mail and passenger steamers for service between Holland and South America. These are the *Gelria* and *Tubantia,* sister ships, 560 feet long, 66 feet beam, 39 feet depth, with a gross tonnage of 14,053, propelled by quadruple expansion engines with cylinders 28, 40, 57 and 82 inches diameter, with a common stroke of 54 inches and using steam at 220 pounds pressure supplied by three double-ended and six single-ended Scotch boilers, working under Howden's system of forced draft. On trial the *Gelria,* with her engines developing 12,000 indicated horsepower, obtained speeds over the measured mile ranging from 16½ to 17½ knots. The bunker capacity is 2,400 tons and the cargo capacity 9,000 tons. Accommodation is provided for 250 first class, 230 intermediate class, 140 special third class, and 900 third class passengers. The hull is subdivided by five structural decks and nine transverse watertight bulkheads, together with a complete double bottom designed for carrying over 2,000 tons of water ballast. 1 illustration. 1,500 words.—*The Engineer,* October 24.

A New Mounting for Big Naval Guns.—For the benefit of readers unfamiliar with the intricacies of turret construction and gun handling, the general features which are to be found in most modern mountings for big naval guns are described in some detail. Attention is then directed to a new type of gun mounting which has been made by Sir W. G. Armstrong, Whitworth & Co., Ltd., for a battleship which is now under construction at the Elswick Shipyard for a foreign power. The improvements in this mounting lie mainly in the direction of rapid working; but combined with this is economy of gun crew and simplicity of operation. The main feature of the mounting is that one lever works all the machinery in the turret and thus replaces four levers formerly used. The one lever performs the various operations in rotation by working around the four sides of a square, the motion along each side performing a distinct and separate operation; first opening the breech; second, placing the gun in the loading position; third, raising the gun-loading cage; fourth, working the rammer; then by reverse motions withdrawing the rammer, lowering the cage, etc. The mechanism is so interlocked that it is impossible to work the single lever too quickly or for an accident to happen, and yet there is not a single valve in the new mechanism which is not to be found in previous well tried gun mountings. Hydraulic power is used for practically all operations. 5 illustrations. 6,500 words.—*The Engineer,* October 31.

The Saving of Heat Units in Marine Engineering.—By Lieutenant Commander Henry C. Dinger, U. S. N. A strong plea is made in this article for the adoption of combination reciprocating and turbine machinery in battleships for the purpose of bettering the economy of operation. With combination machinery it is claimed that .104 horsepower can be developed per pound of water, or that it will require 9.61 pounds of water per horsepower. The best performance that the marine turbine alone can show is about 11.5 pounds of water per shaft horsepower. It is further pointed out that combination machinery will provide for a reciprocating engine in which none of the parts is of excessive size; it makes a very simple arrangement in the engine room, reducing piping, valves and fittings; gives 50 percent of full power for backing and, owing to increase in economy, a saving of weight of 15 to 20 percent is possible. The combination is also well adapted for obtaining the benefit of a reheater and series feed heater. The actual gain in economy by the installation of such devices may be as high as 8 percent, or even more, depending on the degree of saving the process of reheating will produce. A 4 percent gain in economy, it is claimed, is almost certain. It is pointed out that if 80 percent efficiency can be secured for the reciprocating engine, which seems possible, and if some improvement can also be made in the low-pressure turbine an efficiency of 78 percent at full power for combination machinery may be expected and a water rate of 8.3 pounds per horsepower is a practical possibility. By the use of heaters

and series feed heaters these results will be bettered still further, so that an efficiency of 80 percent for the whole range and a water consumption of about 8 pounds of water per horsepower for a large marine installation is within the limits of possibility. For certain classes of work the geared turbine is favorably mentioned. As to future possibilities, the proposition is suggested of using electric motor drive on the shafts with the current supplied partly by Diesel engines and partly by steam turbines. The exhaust from the oil engines could be utilized to assist in the generation of steam in the boilers, and the feed water for the boilers might be used as the cooling water for the oil engines. Such a combination would permit of very great economy and would at the same time enable the propellers to be operated by either the oil engine or the steam engine. Besides the main engines, the auxiliaries should be considered in any attempt to better the economy of operation of a ship. The auxiliaries on a battleship require from 15 to 25 percent of the fuel when under way and their economical operation has a most important bearing on the total fuel consumption because they are continually in operation. The principal auxiliaries are the electrical plant and the evaporator plant. These two services make up about two-thirds of the port consumption. The present average port consumption for large vessels runs at about 25 tons per day. Some of the large vessels get down to about 20 tons per day and occasionally to 18 tons. By taking advantage of improvements in auxiliary machinery it is maintained that large vessels can be brought down to a daily consumption of about 14 tons per day, provided the numerous small wastes are checked. 2 illustrations. 8,700 words. *Journal of the American Society of Naval Engineers,* August.

The Development of the Torpedo-Boat Destroyer.—By W. Lambert. After defining the scope and functions of the modern destroyer as distinguished from the former torpedo boat attention is directed to the classes of destroyers developed in succeeding years for the British Navy. Starting with the "River class," which was comprised of vessels of 550 tons displacement, and 7,500 horsepower, burning coal as fuel, the development is traced to the present-day destroyers of over 1,000 tons displacement and 32 knots speed, using oil fuel and turbine engines. Practically every form of high speed lightweight machinery has been tried in this class of vessel, and the present-day practice must be considered as the survival of the fittest. The present-day tendencies in destroyer design are undoubtedly in the direction of increased speed, armament and sea-going qualities, with a consequent increase in size. The fastest destroyer yet completed is the *Novik,* which attained on her six hours' trial a remarkable speed of 36.3 knots. Another 36-knot destroyer was built in England in 1908, named the *Swift.* Her displacement was 2,170 tons and her shaft horsepower 30,000 to 35,000, but she proved a costly experiment and has not been repeated. 12 illustrations. 2,300 words.—*The Shipbuilder,* December.

Motor Ship for the Hamburg-American Company.—A description is given of the new Junkers-Weser engined vessel *Priemus* of 2,000 horsepower, designed and built by the Weser Company for the Hamburg-American Company. She is a vessel of 6,000 tons deadweight capacity, 353 feet long overall, 50 feet extreme beam, 26 feet molded depth, 22½ feet load draft, designed for a speed of 10 knots. Theoretically the Junkers engine should be more efficient for its weight and length than any other type of Diesel engine, particularly as it is practically a double-acting motor, but its greatest drawback is probably to be found in its great height, which is caused by the tandem cylinder arrangement. Whether or not this will make any difference can hardly be told until the *Priemus* has accomplished at least one ocean-going voyage under severe conditions. There are three pairs of cylinders per engine, each pair being arranged in tandem. The bore and stroke are 16 inches and 1,000 brake horsepower is developed by each engine at 120 revolutions per minute. Its overall length is 23½ feet with 9 feet depth and height of 27½ feet. 9 illustrations. 1,700 words.—*The Marine Engineer and Naval Architect,* December.

Twenty Years' Progress in Marine Construction.—By Alexander Gracie, M. V. O., M. Inst. C. E. This article is a reprint of the James Forrest lecture delivered before the Institution of Civil Engineers on Thursday, October 23. In the tendency toward increased comfort, speed and economy in steamships increase in size is undoubtedly the most valuable resource of the naval architect, as it is directly conducive to the attainment of these three desiderata. The most notable epoch-makers of the first eighty years of steam navigation were the introduction of iron about the year 1820; of steel about 1870; of the compound engine in 1854, and of the triple expansion engine in 1881. The condition of marine construction at the beginning of the twenty-year period under review is prefaced by reference to the *Campania,* at that time the premier vessel on the Atlantic. Comparative details are then given of the various large vessels which appeared from year to year during the twenty-year period, including the *Kaiser Wilhelm der Grosse* (1897), the *Deutschland* (1900), the *Cedric* (1901), the *Kaiser Wilhelm II* (1902), and the *Amerika* and *Kaiserin Augusta Victoria* in succeeding years, until in 1905, when the turbine made its appearance on the *Victorian* and *Virginian.* The development of marine construction during recent years has brought out the *Adriatic* (1906), the *Lusitania* and *Mauretania* (1907), the *Otaki* (1908), the *Olympic* (1911) and the *Imperator* (1913). While the foregoing relates to the Atlantic service, which is of first importance in marine construction, a similar discussion is given of the development of the cross channel steamers and reference is made to the introduction of various forms of transmission gear, such as electric, hydraulic and toothed gearing. The development of the cargo or tramp steamer has undergone a no less remarkable change. Their speed has remained practically constant at 11 knots, but, while the 6,400-ton deadweight carrier of 1895 developed 1,400 indicated horsepower and consumed 20 tons of coal daily, her successor of to-day can carry 9,600 tons and steam at the same speed on an expenditure of only 32 tons daily for 2,300 indicated horsepower. Fifty percent more deadweight is carried and 64 percent more power developed, but only 33 percent has been added to the fuel consumed. The coal rate has fallen from 1.6 pounds per horsepower to 1.3 pounds, while for a 3,000-mile average the deadweight carried per ton of coal has increased from 23.5 tons to 26.4 tons. The various improvements in cargo handling gear, crew's accommodations and auxiliaries and fittings in general are enumerated. Changes in boiler design and construction have been small; and while watertube boilers have entirely superseded cylindrical boilers in warships, they have made but little progress in the favor of the average ship owner. 10,000 words.—*Engineering,* October 24.

The United States Naval Engineering Experiment Station, Annapolis, Md.—By Lieutenant Commander E. J. King, U. S. N. The author gives a comprehensive review of the experiment station as to its origin, establishment, equipment, accomplishments and aims. All tests of machinery and apparatus at the experiment station are conducted from a "service" point of view. It is regretted that the results of these tests have only a very limited circulation, and it is urged that some means should be provided for presenting the results of the tests and research work carried on at the station to the engineering world. 9 illustrations. 8,400 words.—*Journal of the American Society of Naval Engineers,* August.

NEW PIER FOR AMERICAN-HAWAIIAN STEAMSHIP COMPANY.—Work on the new American-Hawaiian Steamship Company's pier at the foot of Forty-first street, Brooklyn, N. Y., is nearing completion. The pier will be about 900 feet long, 150 feet wide and two stories high, fitted with special appliances for handling freight.

ENGINEERING SPECIALTIES

Lunkenheimer Pop Safety Valve

The Lunkenheimer "Sentinel" pop safety valve, manufactured by the Lunkenheimer Company, Cincinnati, Ohio., is made either entirely of bronze (Fig. 1) or with iron body and bronze mounted (Fig. 3), and as the working parts are identical a description of one will suffice for both. Reference is therefore had to Fig. 1, which illustrates the bronze construction.

When a pop valve is ordered the purchaser, as a rule, stipulates the pressure at which he desires the valve to relieve, but after the valve is connected certain conditions may arise that require a resetting of the valve. With the Lunkenheimer construction it is not necessary that the entire valve be taken apart for this purpose, it being only necessary to remove the lever *U*, then the bonnet *C*, when access can be had to the regulating screw *L*. Should it be desired to have the valve

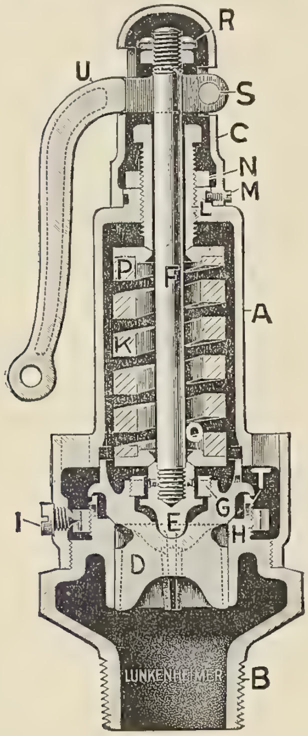


Fig. 1

Fig. 2

relieve at a higher pressure than that for which it was set, the regulating screw *L* is turned down, placing a greater load on the spring, and for a lower pressure it is turned up, which relieves the load.

It is usually found that after a valve has been reset it will either relieve too much or not enough pressure. This is rectified, in the Lunkenheimer improved construction, by a regulating ring *H*, located in the base of the valve, and which screws over an extension of the seat. The object of this ring is to cover or uncover, as the case may require, a series of holes *T* drilled around the extension of the seat, and by removing the set screw *I* and inserting a wire, the regulating ring *H* can be turned up or down as desired. By turning the ring *H* up, covering the holes, only a small quantity of steam can escape through these holes, which places a large amount of pressure on the bottom of the disk flange or lip, giving it a higher lift and holding it longer off its seat, thereby allowing considerable steam to escape and a proportionate amount of pressure. Turning the ring *H* down uncovers the holes, allowing the free escape of steam through them, but inasmuch as the pressure on the bottom of the disk flange is decreased, the disk will not rise very far off its seat, closes quicker, permits but a small amount of steam to escape, and therefore a small reduction in pressure. This improved construction, it is claimed, enables a very wide range in reduction of pressure—from as low as 1 pound to as high as 15 pounds, depending, of course, on the pressure carried in the boiler.

It will be noticed, by reference to Fig. 1, that an extension on the top of the disk *G* fits within the bottom of the bell *A*. The object of this is to thoroughly encase the spring *K*, thereby protecting it from the corrosive action of the steam.

The valve shown in Fig. 1 is of the top outlet pattern, but where it is desired to have the escaping steam exhaust at a

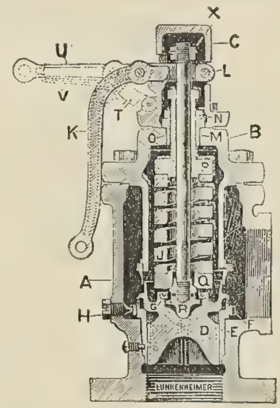


Fig. 3

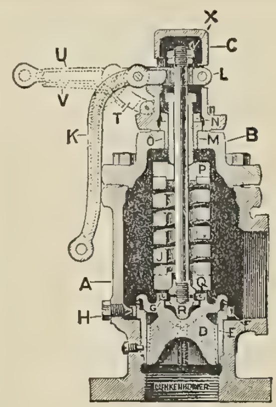


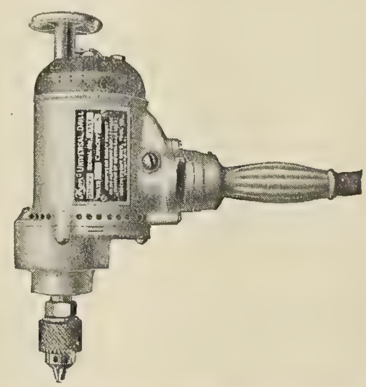
Fig. 4

distance from the valve, the angle pattern (Fig. 2) should be used, which permits of the connection of a pipe at the side.

A comparison of Figs. 3 and 4, which illustrate iron body types, will show that the working parts are practically the same, but that the spring casing has been omitted in Fig. 4, and the spring is consequently not protected from the steam. In some cases, however, it is not considered essential that the spring be encased, hence the necessity of a design like Fig. 4, which is known as the "Plain Pattern."

Thor Electric Drill

The illustration shows a marvelously compact tool, manufactured by the Independent Pneumatic Tool Company, Chicago, for drilling in steel or wood on 110 or 220 volts, direct

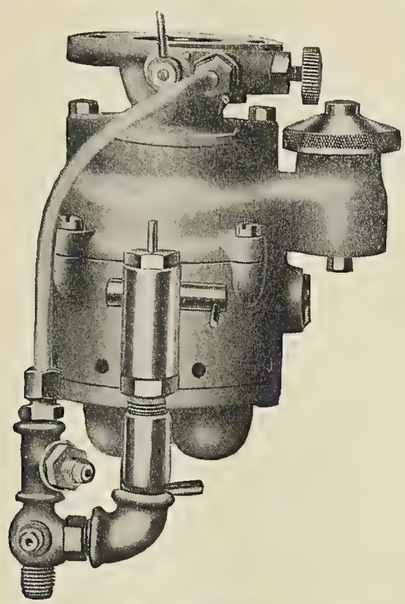


or single-phase alternating current. The tool is built in two sizes, with a capacity for drilling ¼-inch and 5/16-inch holes in steel or ⅜ inch and ½ inch in wood. As the tool can be attached to an ordinary incandescent lighting socket, with alternating or direct-current line, its usefulness is apparent. The spindle and armature shaft are suspended in roller and anti-friction ball bearings. The revolving parts, it is claimed, are perfectly balanced, insuring absence of vibration with great speed and power. The case is made of aluminum, and an ingenious switch at the throttle prevents short circuiting or arcing, and allows interchange of different extension lengths

of cord. The brush holders are automatic and self-adjusted, and the armature is quickly accessible for cleaning by the removal of one nut. The motor is air-cooled by drafts of air drawn through perforated holes in the brush cover at the top of the drill, passing the motor and ejected through a number of small holes around the case, which connects with a groove on the outside of the fan. These tools weigh 6 and 7 pounds, respectively. The speed under load is 1,500 and 750 revolutions per minute, and the reaming capacity 3/16 inch and ¼ inch.

Knox Kerosene (Paraffin) Carburetor, Model E

The Camden Anchor-Rockland Machine Company, of Camden, Me., manufacturers of the Knox Marine Motor, are about to place on the market their Model E carburetor, designed especially to use kerosene (paraffin) fuel on all internal combustion motors. Its operation is briefly described as follows: The fuel is introduced into the carburetor in the usual way, but in the base of the carburetor is built a conical-shaped heating chamber. The heat is taken from the exhaust line, and the amount of heat thrown into the base of the carburetor is regulated by a damper in the exhaust line. Owing to the fact that the fuel-heating chamber is only sufficiently



large to allow the fuel to flow over the cone, and also owing to the fact that the cone is made of soft sheet copper and has a very large heating surface, there is no difficulty in gasifying the fuel as it passes by the needle valve, which the manufacturers claim is the only correct method of handling kerosene (paraffin) fuel.

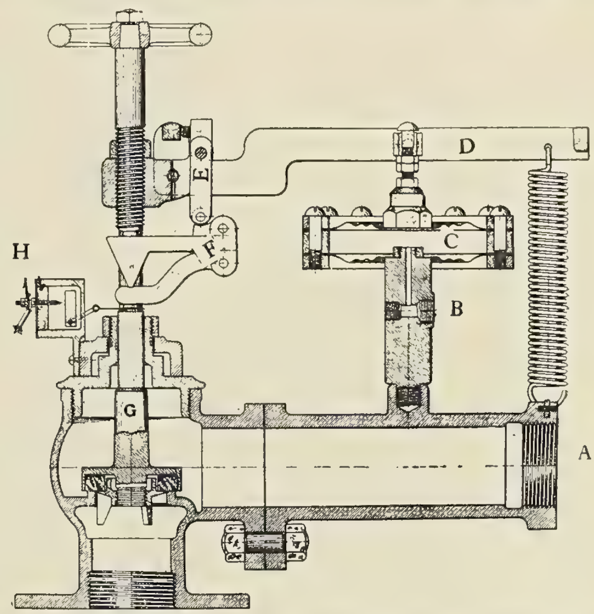
The needle valve and nozzle are of peculiar construction. The gasing fuel passes by the regulating needle into the nozzle through a series of very fine holes. The heated constant air is introduced into the nozzle through a series of small holes. This nozzle is so constructed that the fuel holes intersect the constant air holes at the outlet point, thereby atomizing the mixture as it enters the mixing chamber. The needle valve and nozzle are adjustable, and are made to lift up and down by the movement of the throttle lever. The auxiliary valve which controls the auxiliary air acts as a throttle, and no other throttle is necessary.

The special valuable features of this carburetor, which are covered by patents, are the method of heating the fuel, the method of increasing the speed of the gases and the method of thoroughly atomizing the mixture. The carburetor is so arranged that either fuel can be used—gasolene (petrol) or kerosene (paraffin)—but for convenience' sake it is constructed with a flushing valve, and the gasolene (petrol) is not passed through the carburetor. When the motor is started it receives at first gasolene (petrol) fuel by opening the flushing valve, which has a needle regulation. After running a few minutes (the time varies according to the conditions, say from 15 seconds to 3 minutes) the flushing valve is closed, and the kerosene (paraffin) fuel is picked up without any change in the regulation.

From experience the manufacturers have found that the gain in speed and power when operating on kerosene (paraffin) averages about 7 percent over gasolene (petrol), the fuel consumption remaining practically the same. Under ordinary conditions the marine motor can be started cold on kerosene (paraffin) by simply giving it a good priming charge of gasolene (petrol).

"Nyasco" Fire Protection System

The "Nyasco" system of fire detection and extinguishment in cargo holds, tank ships, tank barges, etc., consists of an automatic releasing valve, together with an open system of piping attached to the valve at *A* for distributing the extinguishing agent, and a smaller closed system of piping attached to the valve at *B*, containing air under a light pressure and provided with fusible plugs at proper intervals in the



space to be protected. The fusing of one or more of these plugs releases the air in the diaphragm *C*, and the controlling bar *D* falls, disengaging the trip lever *E* from the two-piece strut *F*, thereby permitting spindle *G* to rise, thus releasing the extinguishing agent into the distributing system *A*, at the same time sounding an alarm through circuit closer *H*.

The value of any form of alarm is enhanced when the delivery of the extinguishing agent is coincident with such alarm. This, it is claimed, is accomplished by the "Nyasco" system. The fact that quite often the fire is discovered or detected so long after its inception that it has attained proportions that make it practically invulnerable to attack, proves the necessity of automatic action of the extinguishing agent. Whether such automatic system be the water sprinkle type or for the distribution of steam or gases, the "Nyasco" system can be adapted. The valve is simple in construction, positive in action, and by reason of these features it is claimed the system is rendered thoroughly dependable. The air pressure maintained need not exceed 20 pounds per square inch under any conditions, as the pressure on the seat of spindle *G* bears no relation to the air pressure in diaphragm *C*. No auxiliary apparatus is required other than a small air pump

This apparatus is manufactured by the New York Automatic Sprinkler Company, New York City.

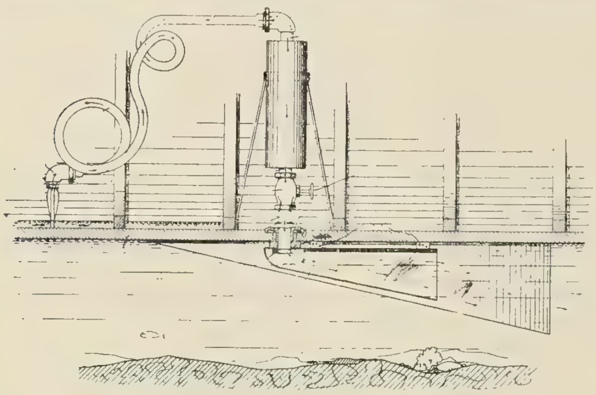
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,072,398. BILGE-WATER DISCHARGER. EUGENE LANGLEY, OF SAN ANTONIO, TEX.

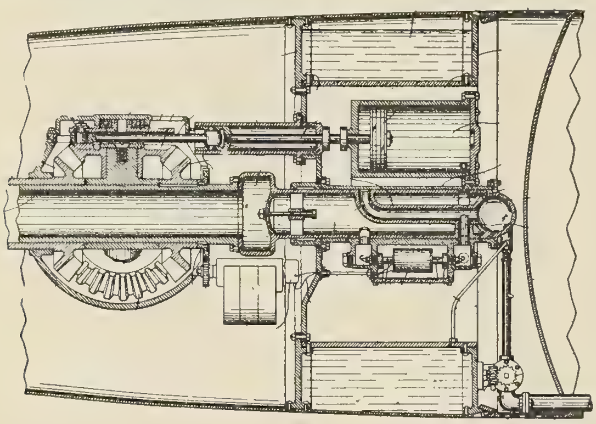
Claim 1.—In a device of the kind described, a check valve consisting of a cylindrical casing having a bushing at each end, rings within said casing bearing against said bushing, a nozzle carried by the upper ring,



pairs of rods connecting said rings, a stop plate fixedly mounted on two of said rods, and a ball valve normally resting on the stop plate. Five claims.

1,077,311. SUBMARINE TORPEDO. HAROLD W. SHONNARD, OF EAST ORANGE, N. J.

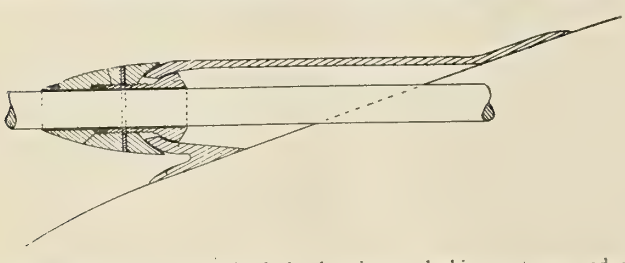
Claim 1.—In a self-propelled torpedo, a water-tight bulkhead, a propeller shaft having its forward end near side bulkhead, a compartment accessible to the seat directly forward of said bulkhead, a heat



engine in said compartment comprising cylinders and pistons grouped around the axis of and suitably connected with said shaft, a tight valve casing piercing said bulkhead in the line of said shaft, and a rotary valve for said cylinders within said valve casing, attached to said shaft. Fifteen claims.

1,075,080. STUFFING-BOX AND BEARING FOR SHAFTS OF MARINE PROPELLERS. HENRY DOUGLAS BACON, OF BATH, MAINE.

Claim 2.—The combination with a chambered housing adapted to be attached to a boat hull and having a conical outer end, a sleeve bearing having a hemispherical head formed on lines concentric with the inner



and outer sides of the end of the housing, a locking nut screwed on the sleeve and having its inner face formed concentrically with the adjacent end of the sleeve bearing, and a fair-water nut also screwed on the sleeve bearing and tapered toward its outer end on lines coinciding with the outer side of the locking nut. Two claims.

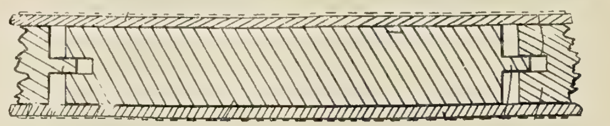
1,078,270. SCREW-PROPELLER. ANTOINE PADOUE FILIPPI, OF PARIS, FRANCE.

Claim.—A screw propeller comprising a plurality of blades, in each of which the pitch increases from the hub to the end, and from the leading edge to the trailing edge, the front face of each blade being provided with an inclined surface adjacent its trailing edge and adjacent the hub of the propeller, the rear face of each blade being provided with an inclined surface adjacent the hub of the propeller, the planes of said inclined surfaces intersecting one another and passing through the shaft of the propeller, such diverting surfaces forming suitable angles with the blades. One claim.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

6106/1913. BULKHEAD FOR SHIPS. ALEXANDER STEPHEN & SONS, LTD., OF LINTHOUSE, GOVAN AND R. M'ILMOIL.

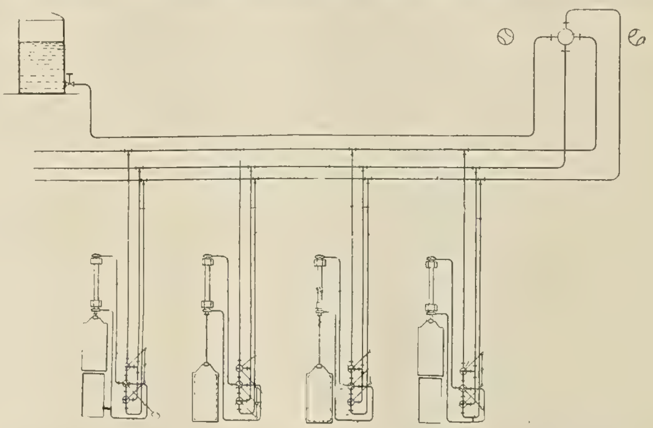
Claim.—To improve the construction of ships' bulkheads they are made fireproof and are so constructed that they do not warp or open out though subjected to extremes of temperature. The bulkhead is



built up of plain wooden boarding lined on each side with sheets of fireproof composition of asbestos and cement secured by nailing. The boards are preferably checked or dovetailed and are arranged with a slight space between to allow for expansion of the wood.

10562/1913. DEVICES FOR USE IN CONTROLLING THE BULKHEAD DOORS ON SHIPS, ATLAS-WERKE AKT. GES. OF "AM TREIHAFEN," BREMEN, GERMANY.

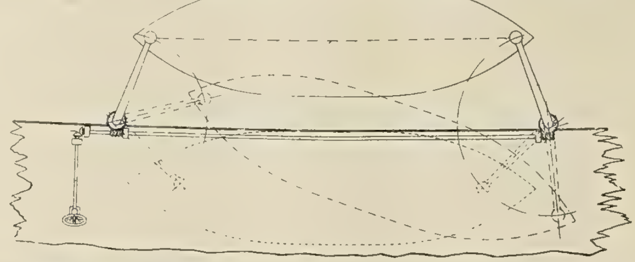
Claim.—A device for use in controlling the bulkhead doors in ships comprises a pressure conduit and a common discharge conduit, two further common conduits being provided and adapted to serve either as pressure or discharge conduits. The supply and discharge conduits



individual to each door operating cylinder are connected to a four-way cock which is interposed between the two three-way cocks individual to that door. The plug levers of the three-way cocks are coupled together to move in unison and the lever of the corresponding four-way cock is movable independently so that when all the doors have been closed from the central controlling point any individual door may be opened locally and caused to be automatically closed upon the lever of the four-way cock being released.

21888/1912. APPARATUS FOR HANDLING AND LAUNCHING SHIPS' BOATS. H. MOWATT, OF 28 PALM GROVE, BIRKENHEAD, CHESTER, AND C. H. BUTTERWORTH.

Claim.—According to this invention each davit of a boat handling and launching gear is provided with a worm-wheel and worms mounted on an operating shaft, the worm gear connecting the shaft to the aft



davit having a higher velocity ratio than the other, and having a limited free rotational movement relatively to the davit. The other worm wheel is keyed to the fore davit whereby the rotation of the operating shaft for launching the boat, although it rotates both in the first instance, only swivels the fore davit—through a considerable arc; the aft davit meanwhile can swivel in-board. When the limiting stops of the worm wheel on the aft davit engage, the latter is swiveled out-board, and the two velocity ratios are such that both davits reach the full out-board position together.

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How the Wireless Works

Explanation of the Various Electrical and Magnetic Effects Taking Place During the Operation of the Instruments

BY J. ANDREW WHITE

There are any number of analogies that may be employed to illustrate the theory of wireless transmission, but none, it would seem, is clearer than the simplest of all. Drop a small stone in a quiet pool of water. A series of wavelets will travel outward in increasingly larger circles. The further they travel the less will be their strength. Now if a chip were floating on the water it would be rocked by each ripple. That is really all there is to it, except that in wireless signaling an electrical power impulse is substituted for the stone, the wave is an invisible one sent through the ether in the air, and the receiving apparatus takes the place of the chip.

The latter point may be made clearer. It is common knowledge that sound travels on invisible waves and registers only on ears that are properly attuned. In other words, sound waves will not impress themselves on the ears of a deaf person, any more than wireless signals will be recorded in apparatus that is not constructed especially for that purpose.

Fig. 1.—Wireless Room of the White Star Liner *Olympic*

With this much in explanation of the theory of wireless signaling, we may pass on to the main purpose of this article: to give a description of the technicalities of a typical set with a simple explanation of the various electrical and magnetic effects taking place during the operation of the instruments. Readers will best be served, perhaps, by confining the explanation to a late type of Marconi set of 1-kilowatt power,

as this apparatus is at present in use aboard a large number of ships.

It is assumed that the reader has some knowledge of elementary electricity and magnetism and is somewhat familiar with the conventionalities of mechanical drawing.

A Typical Wireless Set

Fig. 2 is a complete representation of a Marconi wireless installation, showing all circuits from the direct-current switch up to and including the aerial wires stretched between the masts.

Alternating current is necessary to operate modern wireless sets, and where this is not directly available a motor generator, consisting of a direct-current motor driving an alternating-current dynamo, is used. For compactness both are mounted on the same base and the armatures are usually built on the same shaft. The circuits of one type of machine are clearly indicated to the left of the drawing.

The Direct-Current Motor

The D. C. (direct current) armature consists of a number of coils of wire wound laterally in slots over a soft iron core, the terminals of these windings being connected to the segments of the commutator. The current enters the armature windings through the commutator segments as they pass under the brushes *A* and *B*. The divided circle between the brushes represents the commutator.

The field coil windings of the motor are represented by the spiral wire marked "shunt"; and tracing the conections back it is seen that the terminals are connected across the direct current main line, or in shunt with the armature. The necessary changes of current in the coils of the armature to create changes of flux are made by the commutator.

The Alternating-Current Generator

The alternating-current generator armature is represented by the collector rings marked A. C., and connected to the two terminals of the armature windings. The current is taken from the collector rings through two brushes in sliding contact. Above the generator armature will be seen two field windings, marked "shunt" and "series." The "series" winding is connected in series with the direct-current armature, and the "shunt" winding is in shunt with the direct-current line. This arrangement of the field windings gives a steadier voltage, for when the motor generator slows down under an increased load, and the load is thrown on the generator armature, the direct-current armature requires more current, which causes an increase of current in the series field, because it is connected in series with the direct-current armature. This increase in the series field causes an increase in the magnetic lines of force surrounding the generator armature and a normal voltage is automatically maintained.

The drawing gives the circuits of the rheostat, or starting box, the function of which is to prevent the inrush of current to the windings that would take place if the armature were directly connected to the direct-current mains. The release magnet *R* is connected in series with the shunt field coils as a protection to the motor armature.

Function of the Transformer

When the aerial switch handle is down, and the transmitting key (similar to that used in wire telegraphy) is depressed, alternating currents of low frequency, from 60 to 120 cycles, surge backward and forward through the primary coil of the tansformer. Rising and falling magnetic lines of force are caused by these surgings, and are considerably increased in number by the iron core. These lines of force reverse their direction with the reversals of the current in the coil, and at the same time cut through the secondary winding, inducing in it an electric current of very high pressure or voltage.

In common wireless practice, current at 110 volts is taken into the primary circuit, while the secondary voltage may be 15,000 to 30,000.

Because the current taken in by the primary circuit is at lower voltage than that produced in the secondary circuit this transformer is known as a step-up transformer. It is also known as an open-core transformer, because the magnetic circuit is completed through the air on the outside of the core, in contrast to the closed-core transformer, where the magnetic lines of force have a complete path through the iron.

A voltmeter and ammeter are shown; these respectively indicate the pressure at the terminals of the alternator and measure the current passing through the transformer.

Function of the Condenser

The condenser, or the capacity, is represented at *C* and *C'*, and consists of glass plates covered with tin foil, or, as in this case, glass jars coated inside and outside with copper. In this set there are six jars in parallel in either bank, the two banks being connected in series. This is done to reduce the voltage or pressure on each jar, thereby reducing the chance of puncture. When the condensers become fully charged a discharge takes place across the spark gap, producing an intermittent series of high-frequency electrical oscillations, each one taking place in a very small fraction of a second. The discharge of the condenser takes place through a portion of the primary of the oscillation transformer, the amount of inductance actually in use being determined by the variable contact *F*.

The spark gap acts as a valve, keeping the oscillation circuit idle until the condenser becomes fully charged, then the discharge of the condenser through the spark gap produces high-frequency electrical oscillations.

The circuit, including the condenser, spark gap and the portion of the primary of the oscillation transformer in use, is known as the closed oscillatory circuit, while the circuit, including the aerial, through the secondary helix (a spiral of copper tubing) to the earth, is referred to as the open oscillatory circuit.

Wave Length

As the layman hears a great deal about the wave length of a set, waves varying with the distance to be spanned, it should be noted that circuit-possessing capacity and inductance has a natural time period of oscillation; that is, a certain definite time is required for a complete reversal of current to take place in it. Such a circuit is said to have a definite wave length.

For example, electricity travels at a rate of 300,000,000 meters (186,000 miles) per second, the speed of light. In a wire 100 meters in length a complete oscillation must travel a distance of 200 meters, and the time period of the circuit would be 200/300,000,000, or 1/1,500,000; that is, a complete oscillation takes place in that circuit in 1/1,500,000 of a second. Then it is seen that the circuit oscillates 1,500,000 times per second, and its wave length is 200 meters. Or, in other words, the distance through space traveled by the wave during one complete oscillation or cycle is its wave length. As the wave length of any circuit is determined by the inductance and capacity, if either one is increased the wave length increases.

Changing the Wave Length

Referring to the drawing, if the number of leyden jars, *C* and *C'*, are increased, or if the number of turns of the helix, included by the variable contact *F*, is increased, the wave length is increased, for these are the two factors that determine the time period of the circuit. The wave length of the open circuit is increased or decreased by the helix clip or variable contact *L*, accordingly as more or less turns are included in that circuit. The necessary change of wave length

in the closed circuit is secured by means of the variable contact *F*.

When the condensers *C* and *C'* discharge through the helix via contact *F*, what are known for convenience as magnetic lines of force rise and fall about the helix turns of the closed circuit, which not only cut through these turns but interlink with and cut through the turns in the secondary, setting up in it corresponding oscillations of high frequency, which are reflected up and down the aerial wires, producing electrical waves.

For the best working the open and closed circuits must be placed in resonance—they must have the same period or wave length. The oscillation transformer consists of a coil of fixed value of inductance placed immediately above the turns of the closed circuit helix. This coil is supported by the wooden pillars *R* and *R'*, in such manner that the distance between the fixed inductance and the closed circuit helix can be increased or decreased as desired. The function of the oscillation transformer is not only to transfer energy in the form of high-frequency oscillations from the closed to the open circuits, but also to place these two circuits in resonance, and, further, to allow the wave length of either circuit to be increased or decreased as desired.

A separate coil of inductance is connected in series with the secondary of the oscillation transformer and the antennæ (aerial wires), thus enabling the wave length to be varied as desired. This coil is popularly known as the "loading coil."

How the Message is Sent

When the transmitting key is depressed, currents of high frequency traverse the antennæ or aerial circuit, producing around it fields consisting of electrostatic lines of force and electromagnetic lines of force. Owing to the rapidity of the reversals of current these lines of force do not collapse back upon the wire as they do in currents of lower frequencies, but a portion of the energy is radiated into space.

These displacement currents, which take place in space about the antennæ, create electric waves, and it is by means of these, long and short for dashes and dots, that communication between stations is effected.

Auxiliary Sets

Under the recently-enacted wireless laws passenger-carrying ships must be provided with an auxiliary set with an independent power supply. Storage batteries are used, and when a change is made from the power to the auxiliary set (Fig. 2), a flexible cord with a plug contact is connected to the bottom electrode of the anchor spark gap as shown. When it is desired to use the auxiliary set for transmitting this plug is removed from the aerial tuning inductance and connected to one terminal of the inductance coil. This arrangement is shown in the drawing. The double-pole, double-throw switch makes the connection to the key on the primary of the induction coil.

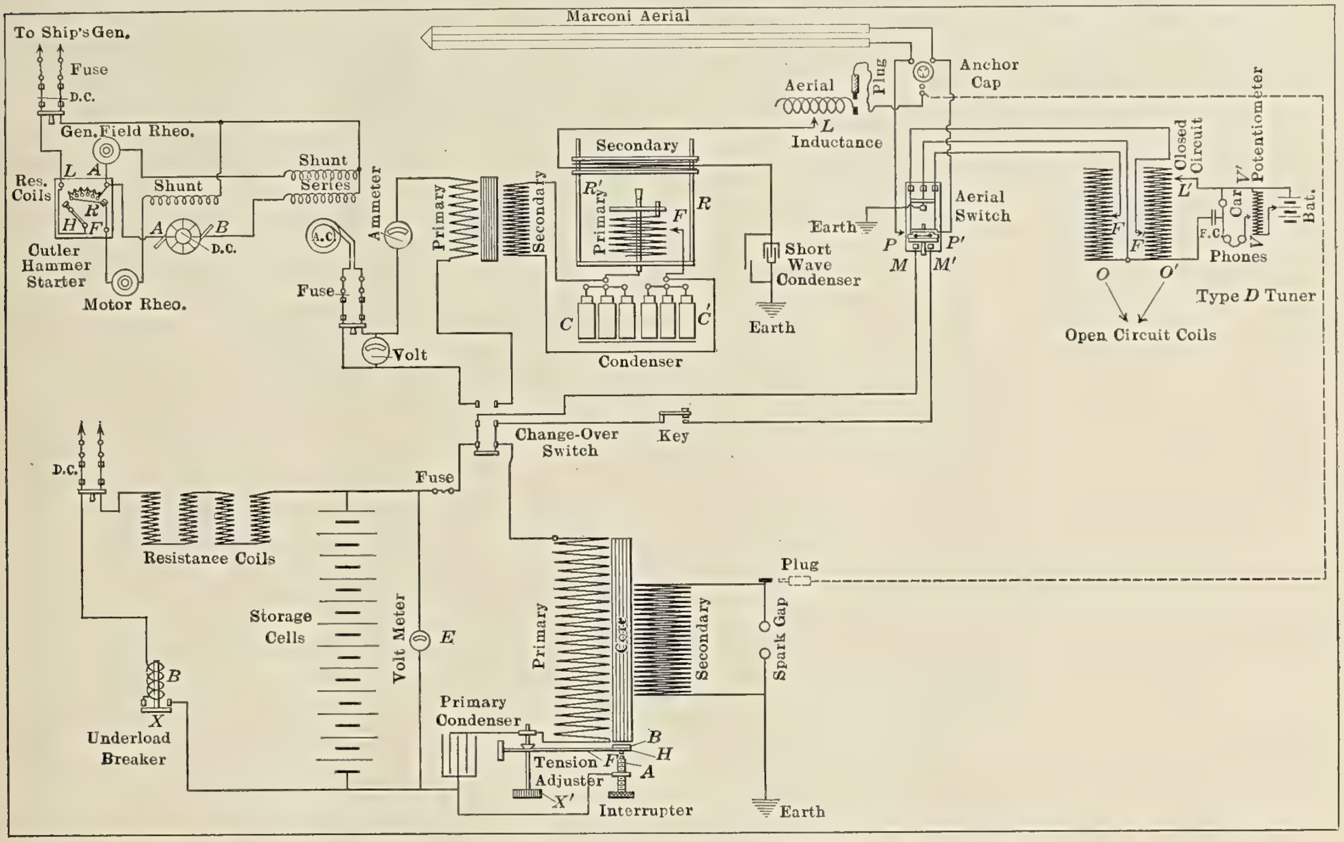

Fig. 2.—Diagrammatic Representation of Complete Marconi Wireless Installation

The circuits of the auxiliary set are clearly shown in the drawing. The set is essentially divided into three parts: chloride storage cells of the portable type, 8 to 16 in number; a 10-inch induction coil, and a slate switchboard, on which are mounted a direct-current switch with fuses, an underload circuit breaker, a double-pole, double-throw switch, 4 series resistance coils, a battery voltmeter and an enclosed fuse in series with the discharge circuit.

The induction coil consists of a primary winding of coarse wire wound over a soft iron core (marked primary) covered with an insulating tube, over which is wound a great number of turns of very fine wire (marked secondary). Both are wound around the iron core, but for clearness the drawing shows the core between the two windings. The interrupter in the primary circuit is indicated by the spring *F*, on which is mounted a piece of soft iron *B*. A platinum contact is fastened to spring *F*. The circuit through the primary is completed through the adjustable platinum contact *A*. On its normal position the spring *F* causes the platinum points to be in electrical contact with one another.

When the double-pole, double-throw switch is in the position shown, the aerial switch pressed down and the transmitting key depressed, current from the storage cells enters the primary coil via contacts *H* and *A*, the magnetic field thus produced being augmented by the presence of the iron core. Immediately the core becomes magnetized it attracts the small piece of iron *B*, which opens the contacts *H* and *A*, interrupting the primary circuit. As the current has stopped there are no magnetic lines of force to hold the spring and it flies back again, closing the circuit through *H* and *A*. This process is repeated several times per second, resulting in the production of rising and falling magnetic lines of force, which intersect and cut through the turns of fine wire in the secondary winding, inducing currents of very high potential or voltage.

A condenser of large capacity is connected directly across the break of the interrupter. This not only serves to eliminate the spark at the interrupter contacts, but also assists in demagnetizing the core after each break of the circuit; thus a more rapid change of magnetic flux in the primary core is secured, giving a greater effective current in the secondary windings. The terminals of the coil are connected directly to the spark gap, which is also connected in series with the antennæ. Since the antennæ possesses capacity in respect to the earth it is capable of being charged, and when the high potential surgings are produced in the secondary of the coil, an electrostatic charge is maintained on the aerial, which finally becomes of such value that a discharge takes place across the spark gap, producing high-frequency oscillations. The surgings produced by these oscillations result in the production of the electromagnetic waves that represent the code message.

Receiving Apparatus

Having considered the details of the transmitter the receiving apparatus may be dealt with briefly, as it is in many points similar to the sending station and uses the same aerial.

It has been explained that the transmitter emits signals in the form of waves of definite lengths and characteristics according to adjustment of the apparatus, and that these waves travel in all directions with the speed of light. To receive these all that is necessary is apparatus which will detect the waves as they strike the receiving aerial and make them intelligible. The receiving apparatus, then, includes a detector to rectify the incoming oscillations, sensitive recorders in the form of telephone receivers, and various inductive and capacity apparatus to attune the station to the wave length of the signals desired and to exclude undesired signals.

When receiving, the aerial switch is lifted up, the primary of the transformer circuit is disconnected, and the receiving apparatus is connected both to the aerial and the earth.

While the detector is not of itself the most sensitive instrument, it is essential because the telephone receiver, to respond to the rapid high-frequency oscillations, would have to possess a diaphragm that would move with a frequency corresponding to approximately one-millionth of a second, which, of course, it cannot do. Therefore the function of the detector is to translate the received oscillations into a current which will operate the receiver. The detector is simply a small piece of crystal mounted between a large and small contact.

Tuning the Circuits of the Transmitter and Receiver

In order to receive signals the receiver must be adjusted until its circuits are attuned to or in resonance with those of the transmitter; for example, if a station is sending out a 600-meter wave the receiver must be adjusted until its wave length is 600 meters, or very nearly so.

The receiving tuner represented is known as type *D*, and by referring to the drawing it will be noted that the aerial is split in two leads brought to the receiving apparatus. As in transmitting circuits the receiving apparatus has both open and closed circuits. The open circuit is represented by coils *O* and *O'*. The wave length of the open circuit is varied by contacts *F* and *F'*. A closed oscillatory circuit is bridged around one of these coils, and the inductance included in that circuit is varied by means of the sliding contact *L'*.

The closed oscillatory circuit includes the carborundum crystal (*CAR*), the fixed condenser (*FC*), and whatever amount of inductance is used as determined by contact *L'*.

The coil to the left of the tuner is the one on which the principal change of wave lengths is made. The action of the tuner is as follows:

When the two coils *O* and *O'* are connected to the antennæ circuit by means of the aerial switch, and the sliders *F* and *F'* properly adjusted to secure resonance, high-frequency oscillations traverse these coils. Those produced in coil *O'* set up magnetic lines of force, which interlink with the adjacent turns of the secondary, setting up counter electromotive force, which passes through the closed oscillatory circuit, including the detector.

A small battery current flowing through the crystal increases its sensitiveness, and because different values of current are required for different crystals a device known as a potentiometer is used. This is indicated in the drawing.

The potentiometer is a variable resistance connected in shunt to the battery, and may be inductive or non-inductive. In this case it consists of a number of carbon resistance rods, connected to a variable point switch in such a manner that the resistance can easily be adjusted. This is done by means of the sliding contact *V*, which, when moved toward *V'*, decreases the current flowing through the head telephones and detector, while a rapid increase in current takes place as the contact is moved away from *V'*. In this way the current is adjusted until the detector reaches its maximum degree of sensitiveness.

While page after page could be covered with explanation of the phenomena encountered in wireless operation, careful study of the drawing and a second reading of this article should be sufficient to give those who are interested a fair working knowledge of how wireless signals are received and transmitted.

Many of those who have been shipmates with wireless, but knew little or nothing of its working, will find a new and interesting field for observation if the drawing and explanation are compared with a regular commercial equipment while the operator points out the various devices.

Half-Yearly Shipbuilding Returns.—The Bureau of Navigation reports 644 sailing, steam and unrigged vessels of 163,849 gross tons built in the United States and officially numbered during the six months ended Dec. 31, 1913. Of these, 53 were steel steam vessels aggregating 93,224 gross tons. The total gross tonnage built during this period was practically the same as that for the corresponding period in 1912, when 791 vessels aggregating 163,584 gross tons were built. The tonnage of steel steam vessels built during the last six months in 1913, however, was somewhat greater than that built in the last six months in 1912, the figures being 93,224 and 89,364, respectively. The tonnage of steel steamships built on the Atlantic coast during this period in 1913 was 16 percent greater than in the same period in 1912, while on the Great Lakes there was a decrease of nearly 30 percent. On the Pacific Coast about the same tonnage of steel steamships was produced in the last six months of both 1912 and 1913.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 87 sailing, steam and unrigged vessels of 22,881 gross tons built in the United States and officially numbered during the month of December, 1913. The largest vessel completed during the month was the *Manoa* of 6,203 gross tons, built for the Matson Navigation Company by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

Change of Shape of Recent Colliers*

Results of Observations of Hogging and Sagging on 500-Foot Naval Colliers—Motion of Tank Top with Reference to the Upper Deck

BY NAVAL CONSTRUCTOR STUART FARRAR SMITH, U. S. N.

That ships bend in the middle has, of course, been well known for generations; and the tendency of wooden ships to hog was so well known that their keels were laid to a curve, which, it was judged from experience, would be approximately straightened out after they were afloat. The old records of the Bureau of Construction and Repair contain much interesting information as to the allowance for hogging in the case of our old wooden sailing and steam vessels, as well as information as to the changes in shape due to launching and loading.

But with the introduction of iron and steel vessels, at first of short length and heavy scantlings, the changes in shape were so slight that they were practically neglected. At the same time the importance of calculating the strength of these comparatively new structures was brought to the notice of designers and the present strength diagram was developed. As the ships grew longer it was apparent that weight could be saved if the superstructures were not built to resist the stresses arising in the upper part of the girder; hence arose the expansion joint in long deck houses on passenger steamers which has brought itself loudly to the attention of the unfortunate landlubbers whose staterooms were near it.

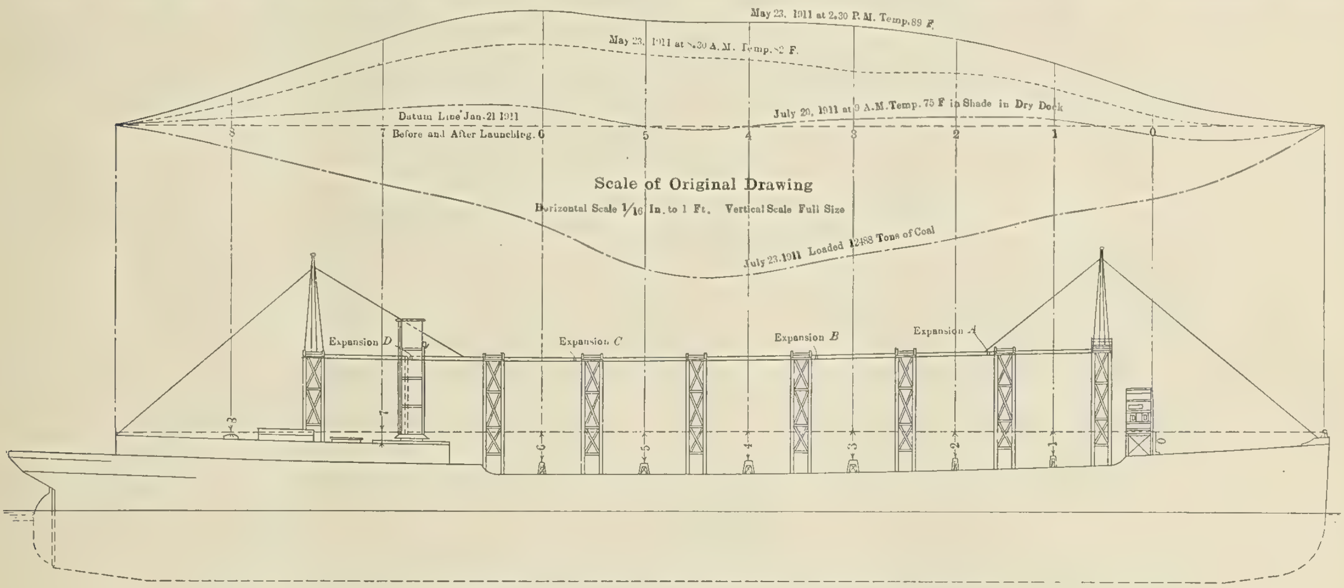

Fig. 1.—U. S. Collier *Neptune*, Curves Showing Hogging and Sagging

It has, therefore, been known for many years that steel ships worked, but the subject of observing the amount of flexion and from that deducing the stresses to see how they compared with the results provided for as a result of the strength diagram, does not seem to have been investigated in proportion to its importance, or to the opportunities which exist for obtaining data.

The observations which are here presented to the society are not as complete as they should be, and consequently only rough deductions can be made. This is partly because as the observations were made it appeared that additional data of different sorts should have been taken. In other words, hindsight was clearer than foresight, and if the observations were to be repeated a good deal more could be learned with very little additional trouble.

Crude as they are, it is hoped that the results may interest some of us enough to make similar observations in such form that strength calculations can be checked, and possibly our designs improved.

The loss of the *Cobra* and *Viper* in England led to an elaborate series of tests on one of the British destroyers. Observations more or less extensive have been made on several of our destroyers, and it is common practice to erect battens or take sights before launching so that any great change in shape when afloat can be ascertained; but these observations have been based largely on the idea that a steel ship does not change much, and that if much change of shape occurs something is wrong. It would probably surprise a good many owners to learn that a 500-foot ship can bend over 6 inches due to loading and be none the worse for it; also to know that a rise in temperature of only 7 degrees may change the shape by an inch.

The amount of change in shape in the keel line of battleships is another matter which is not as fully realized as it ought to be, especially in the case of the new ships with several turrets, and I hope that some one of the members of the society who is in possession of the data will take the trouble to give us the results found by comparing the alinement of turret roller paths afloat and in dry dock.

The observations plotted on Figs. 1, 2 and 3 were taken on the colliers built for the navy by the Maryland Steel Company at Sparrow's Point—the *Neptune, Orion* and *Jason*. The last two were sister ships, built on what is generally known as the Isherwood system, while the first was similar but slightly longer and built with transverse framing.

The *Neptune* was the first ship built and shows considerably more change of shape than the two ships with longitudinal framing, having a maximum of 6½ inches against less than 5 inches for the *Jason* and only 3⅜ inches for the *Orion*. In this statement I omit the *Jason's* condition of April 3, 1913,

*A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

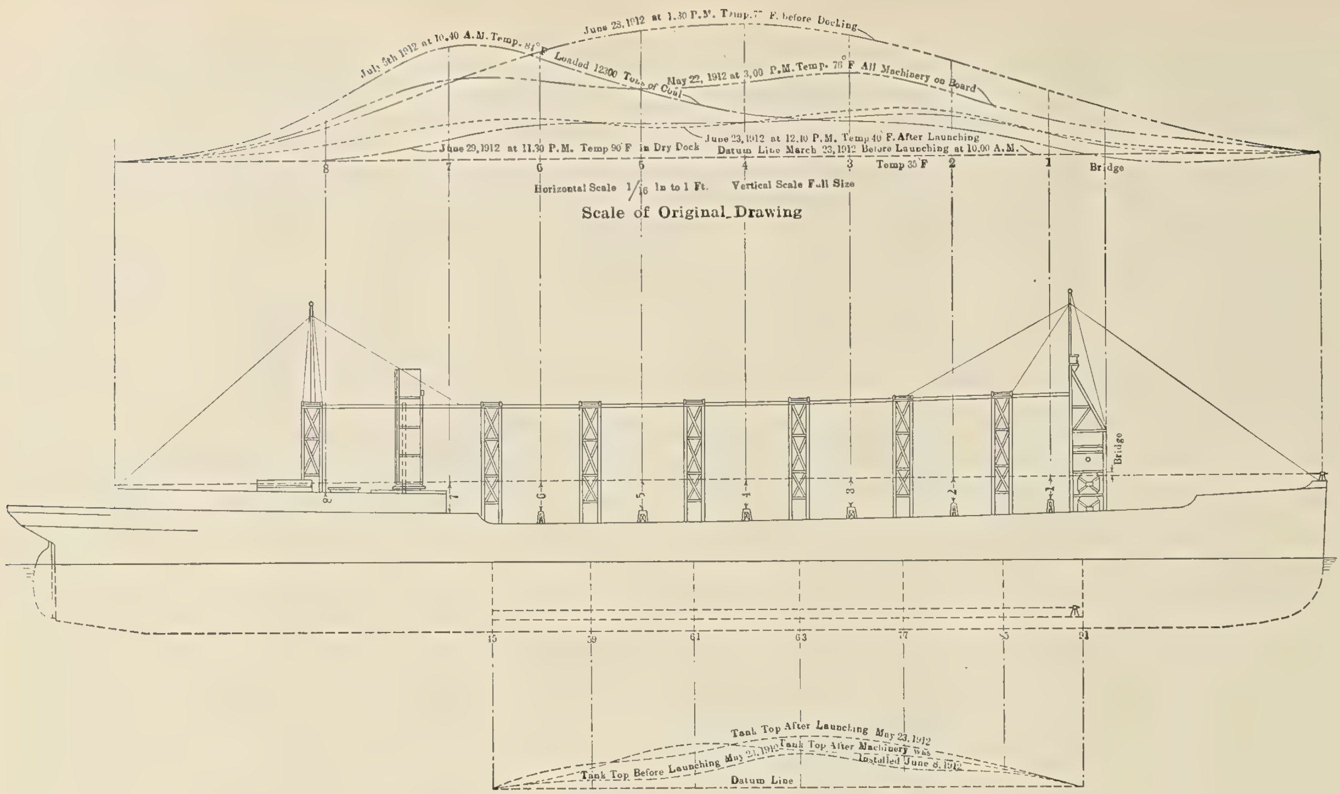

Fig. 2.—U. S. Collier *Orion*, Curves Showing Hogging and Sagging

as she was at that time damaged due to a dynamite explosion on a vessel lying near her.

The sister ships show surprisingly different results. The *Orion* showed considerable hogging immediately after launching, while the *Jason*, like the *Neptune*,' remained nearly straight. Moreover, the *Orion* when loaded showed no sagging, but the point of maximum hogging simply moved aft somewhat as if her cargo had rolled her "hump" toward the stern. The *Jason*, on the other hand, behaved like the transverse-framed *Neptune* and changed from slight hogging when light, to a considerable sag when loaded. The cause may lie in the difference in the tank tops, as I shall explain.

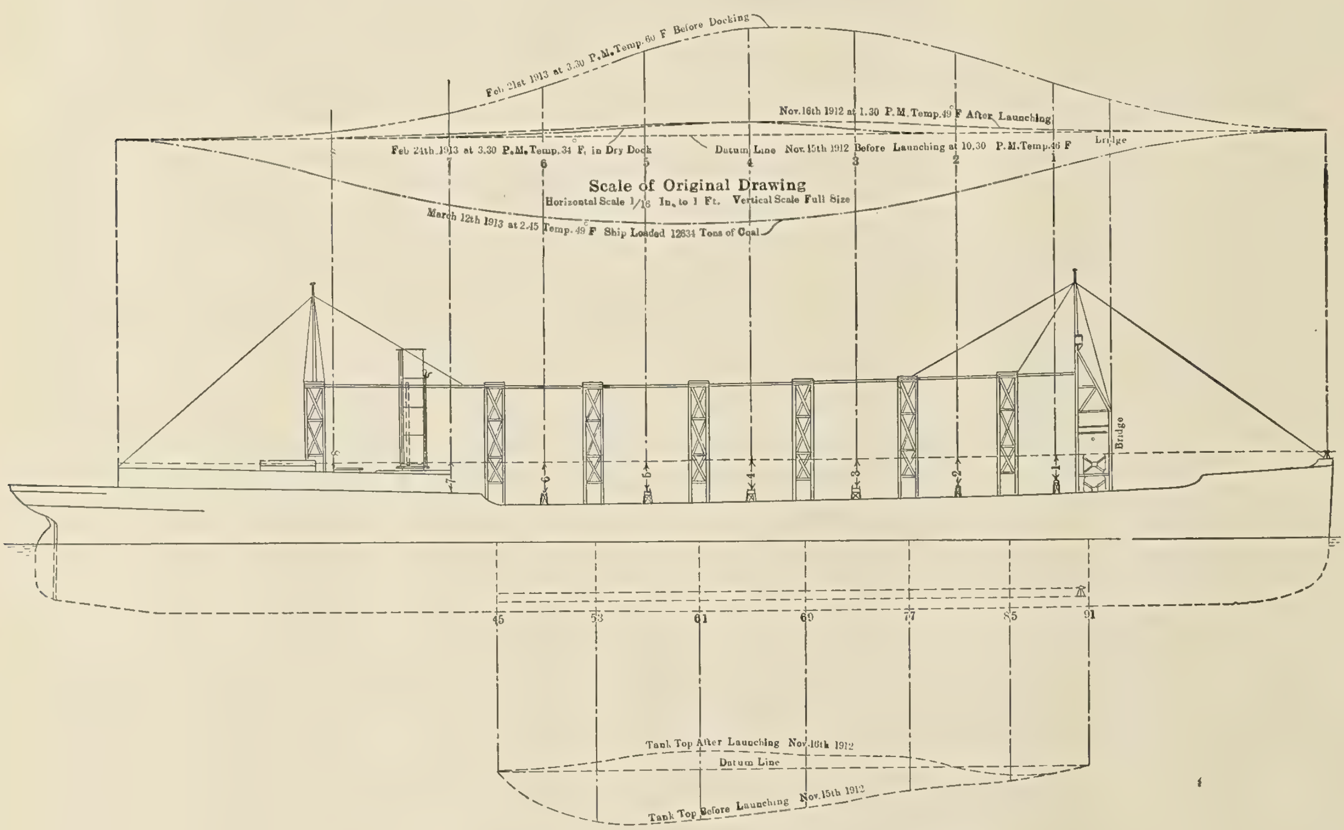

Fig. 3.—U. S. Collier *Jason*, Curves Showing Hogging and Sagging

After the observations had been made on the *Neptune*, the question arose: "If a ship bends, that is, if the main deck is forced up or down, what happens to the bottom?" As a result of this, on the two later vessels sights were taken through openings left near the foot of each bulkhead in the cargo holds. Observations of the height of the sight line above tank tops are plotted in Figs. 2 and 3; these show that the *Orion's* tank top was convex, while the *Jason's* was concave before launching. As all three of these vessels were built on the same ways, it is unlikely that the blocks settled so differently, and it is therefore probable that the curve in the tank top was due to slight structural unfairness. The intial convexity in the *Orion*, which remained even when loaded, would seem a desirable thing, as it apparently resulted in reducing considerably the maximum change of shape, and may have acted to a small extent after the manner of an arch.

Another point, although to be expected, is that none of these ships came back to its original shape when docked.

In connection with the tank top curves, it should be noted that while the deck of the *Jason* at Station No. 5 went up only 5/16 inch after launching, the tank top immediately below was forced up 1⅝ inches. On the *Orion*, where there was an initial convexity of the tank top, it rose 13/16 inch, while the deck at Station No. 5 rose ¾ inch.

As originally planned on the *Neptune*, there were no stations for sights aft of the cargo holds. Just before completion it was decided to establish Stations Nos. 7 and 8, and readings were taken at the last two sets of observations, but as they did not materially alter the curve, these additional stations were omitted on the later vessels.

Of these colliers, only the *Neptune* had expansion joints in the track for handling coal fore and aft, and on her some observations were taken to make sure that the joints allowed sufficient play to relieve the track from undue longitudinal stress. The readings show that for an increase of sag of about 3 inches there was no motion at all in the joints. The first set of readings were taken without reference to the question of change in shape of the hull, but as the ship was substantially in the same state on May 23 as on June 14, it will be seen that in changing from maximum hog to maximum sag practically no motion took place in the joints.

In the case of each of the three ships, the change in shape due to fitting out after launching is obscured by the rising temperature, which produced a hog; while the effect of the former is not clear, some light is thrown on this by the tank top curve in the case of the *Orion*, which shows that putting in the machinery reduced the hog of the tank top, although, owing to much higher temperature, the hog of the upper deck had been considerably increased.

As regards change in shape due to temperature alone, none of the observations on either the *Orion* or the *Jason* afforded any good comparison. In the case of the latter, there are, it is true, two observations made at different times with the ship complete, but the conditions of loading, etc., as indicated by drafts, show that these cannot properly be compared with one another. This lack of ability to compare the temperature effects is the more regrettable, as it was on these two ships that tank top readings were possible.

On the *Neptune*, however, two sets of readings were taken on the same day and under the same conditions of loading. The ship was very nearly complete, and if tank top readings had been possible the result would have been even more valuable. These observations show that for a rise of temperature of 7 degrees F. the maximum hogging increased 1 inch, while the two curves (Fig. 1) show that the effect was fairly uniform throughout the length of the vessel.

The method of taking sights was very simple. A transit instrument mounted on a special short-legged stand was placed on a breast hook at the stem head, its center being located over a punch mark on the plate of the breast hook. The transit was sighted on a permanent target located at the after end of the deck house, and the heights were observed by a measuring rod held vertically on each of the hatch cover supports, which were used as the observing stations.

Fig. 4 shows curves from some observations made on the collier *Nereus*, built by the Newport News Shipbuilding and Dry Dock Company, and though the method of observing was somewhat different, and the resulting curves were differently plotted ,a comparison with the other vessels is interesting.

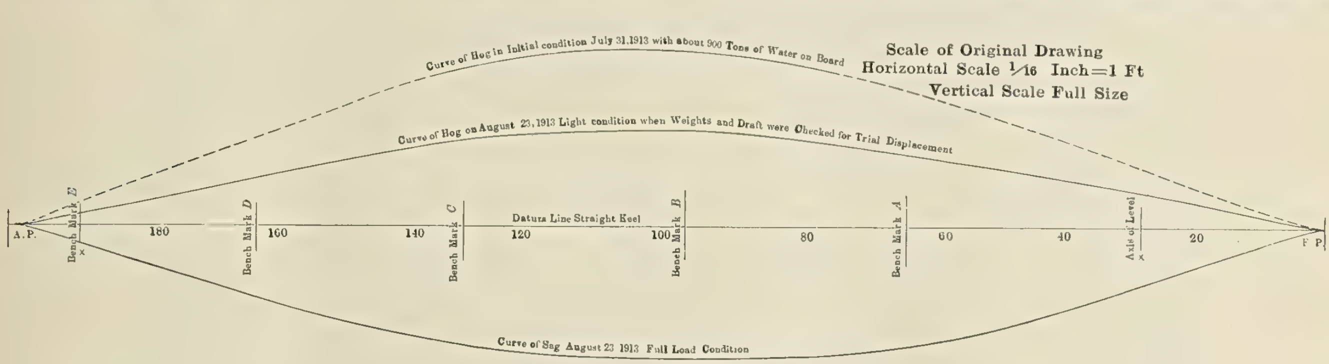

Fig. 4.—*Nereus*. Curves of Hogging and Sagging

The *Nereus* is in general similar to the *Orion* and *Jason*, except that she is 10 feet shorter and is built with the ordinary transverse framing. No sights were taken before launching, but a line was run when the vessel was practically complete. A second set of sights was taken in dock, and on the assumption that she had straightened out, this latter set was then used as establishing the datum line; and the curves shown on Fig. 4 were plotted for hog and sag, although all the readings were taken as sag.

In conclusion, I wish to express my obligations to Mr. T. M. Cornbrooks, chief engineer of the marine department of the Maryland Steel Company, as it is largely due to the interest in this matter taken by him and by his assistants that these observations were made.

Lloyd's Shipbuilding Returns.—According to returns compiled by Lloyd's Register of Shipping, which take into account only vessels the construction of which has actually begun, there were, excluding warships, 513 vessels of 1,956,606 gross tons under construction in the United Kingdom at the close of the quarter ended Dec. 31, 1913. The tonnage now under construction is about 30,000 less than that which was in hand at the end of the last quarter, and about 13,000 tons less than that building in December, 1912. Of the vessels under construction in the United Kingdom at the end of December, 420 of 1,557,551 gross tons were under the inspection of Lloyd's surveyors with a view to classification by the society. In addition 116 vessels of 497,976 tons are building in other countries under Lloyd's survey, making a total of 536 vessels of 2,055,527 tons now building under the supervision of Lloyd's Register.

Four 250-Ton Giant Cranes Now Under Construction for Use in Shipyards

In the same degree as the dimensions of mercantile and war vessels increase, the shipyard equipment, such as building berths, floating and wharf cranes have to become more powerful and efficient. Cranes of 150 tons capacity, which were considered amply large enough only a few years ago, prove insufficient for handling the heavy machinery parts, turrets, etc., which enter into the construction of modern ships. Also the outreaches of these cranes have to be increased, owing to the increase in the width of the boats. Under these conditions leading German shipyards find it necessary to add to their equipment cranes of 250 tons capacity.

In the October issue of 1913 we gave a description of the new 250-ton wharf crane for Blohm & Voss at Hamburg. At present the Deutsche Maschinenfabrik at Duisburg, represented in New York by Neumeyer & Dimond, has under construction, besides the two 250-ton floating cranes for the Isthmian Canal Commission, a 250-ton revolving floating crane for the Imperial Navy Yard at Wilhelmshaven, and a 250-ton wharf crane of the hammer type for the Shipyard Schichau at Danzig.

The 250-ton wharf crane for the Schichau Shipyard is similar in design to the one shown in Fig. 1. It was originally ordered for a capacity of 200 tons, but during construction it was decided to increase the capacity to 250 tons. It is equipped with one 250-ton trolley and one 50-ton trolley, both running on the same track inside of the long arm of the jib. A revolving traveling crane runs on the top chord over the entire length of the jib and has two hooks of 20 and 5 tons capacity, respectively. The top chord of the jib is 187 feet above the wharf and its entire length is about 320 feet. The importance of the revolving traveling crane on top of the large crane has been discussed on page 438 of the October, 1913, issue of this paper and is well illustrated by Fig. 1, showing the setting of a mast.

The crane is electrically driven throughout. The maximum load of 250 tons can be lifted at a distance of 105 feet from the center of the crane, or 74 feet from the edge of the quay wall. The 50-ton trolley is principally used for attaching armor plates and it can handle the full load at a distance of 180 feet from the center. The five-ton hook of the auxiliary crane has a radius of 33 feet and can take up loads at 216 feet from the center of the crane, covering an area of 3.3 acres in a full revolution of the big crane. The operator's cabin is about 160 feet above water level and the entire crane is controlled by one man.

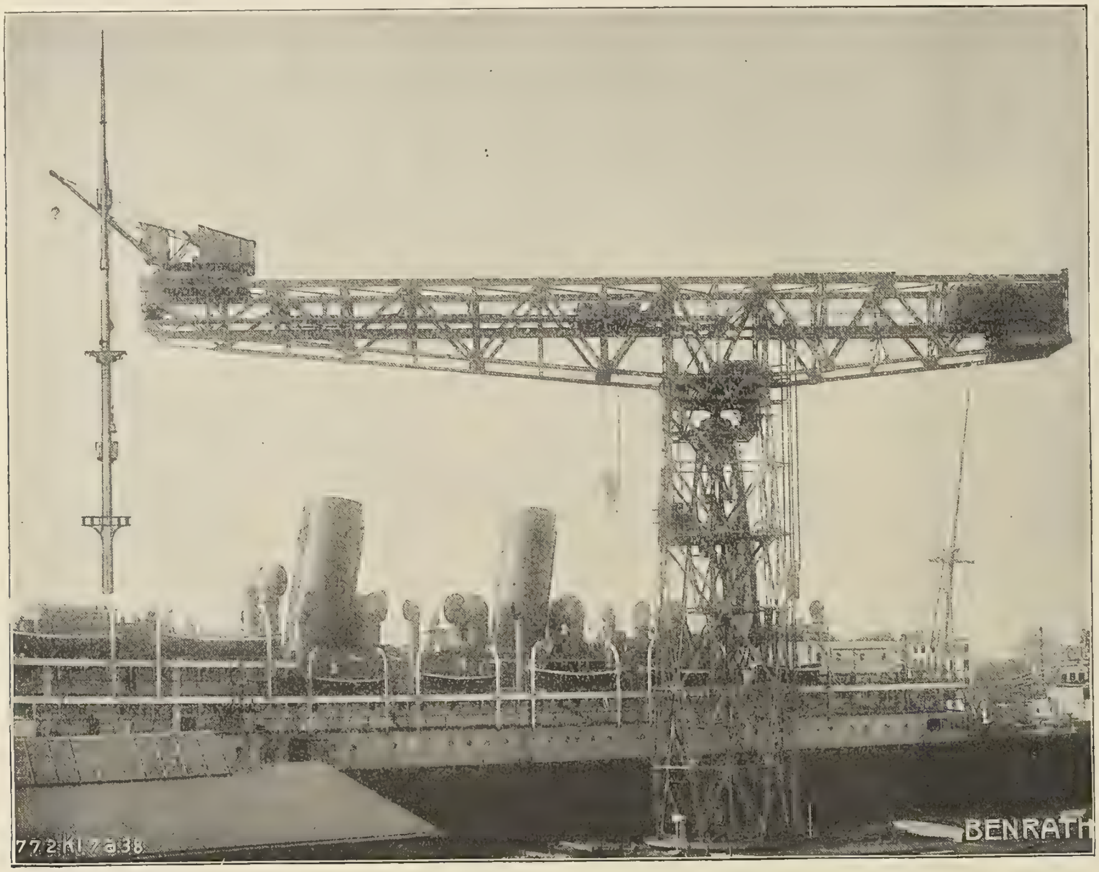

Fig. 1.—Wharf Crane of Hammer Head Type

The floating crane for Wilhelmshaven is of the same type as the cranes for Panama, which are similar in design to the crane illustrated in Fig. 2, but it has a larger outreach and several additional hooks. It can lift the maximum load of 250 tons at a distance of 59 feet from the fender over three sides of the rectangular pontoon, whereas the outreach of the Panama cranes under the same conditions is only 24.5 feet. The pontoon has a beam of 100 feet and can carry a deck load of 500 tons. While the Panama cranes have two 125-ton hooks at the end of the jib and a 15-ton climbing trolley, the new crane carries a 50-ton hook at the end of the jib, two 125-ton hooks about 40 feet below same, a 20-ton climbing trolley and a 10-ton hook alongside of each one of the two large hooks. The 10-ton hooks are used mainly for handling the chains and slings when attaching and detaching heavy loads to and from the big hooks. Loads of 50 tons can be raised at a clear reach of 130 feet over the fender.

The hoisting, luffing and revolving motions are driven by direct current electric motors, which receive their current from two generating sets, each driven by a steam turbine located in the pontoon. One set is for reserve. The current for the electric light and for exciting the motors is furnished by a

separate steam-driven unit and provision is made that this current can be supplied from land also.

The entire controlling apparatus is placed in the operator's cabin below the pivot of the jib, about 65 feet above the water

Fig. 2.—Floating Crane

level. The machinery of the crane is attached to the lower end of the revolving part of the crane structure.

Unlike the Panama cranes, which have to be towed, the new crane is self-propelled by two screws, each driven by a 500 horsepower triple-expansion steam engine.

Collier Hampden

The New York Shipbuilding Company, Camden, N. J., is now building for the Coastwise Transportation Company, Boston, Mass., a steel screw collier of the following dimensions:

Length between perpendiculars	377 feet 4 inches
Beam, molded	50 feet
Depth, molded	32 feet
Draft, loaded	25 feet
Gross tonnage	4,727 tons
Speed at sea, loaded	10 knots

The vessel is of the same type as the *Coastwise, Transportation, Suffolk, Norfolk* and *Middlesex,* built by the New York Shipbuilding Company for the same owners during the last four years, although the dimensions and deadweight have been increased. The construction is in accordance with the requirements of Lloyd's Register.

Hull Construction

The vessel has a single deck of steel, with poop 80 feet, bridge 17 feet and forecastle 34 feet long, eight steel watertight bulkheads, two pole masts, a straight stem and semielliptical stern. A deep double bottom is fitted all fore and aft for the carriage of water ballast. Particular attention has been paid to the construction of this part of the vessel; the plating is of extra strength and fitted flush; no wood ceiling is fitted. Water ballast is also carried in a deep tank amidships.

The five cargo holds are entirely clear of beams and pillars, the deck being supported by deep arched beams and web frames fitted midway between the watertight bulkheads.

A continuous trunk 24 inches deep by 30 feet wide is carried on the upper deck for the full length of the cargo spaces, the sides forming strength girders between the bulkheads. Large steel cargo hatches are fitted on top of this trunk, eleven in all, three to the main hold and two to each of the other holds. Six steam winches are fitted in connection with six pairs of king posts for raising the hatch covers and securing them in place when open. A cargo boom is fitted on the foremast for handling stores, etc.

The coal bunkers are at the sides of the vessel in the boiler room and in the poop 'tween decks, with hatches on the poop deck and pockets leading to the fireroom. The peaks are both fitted as water ballast tanks.

Collier *Hampden*, Built by the New York Shipbuilding Co. for the Coastwise Transportation Co.

Accommodations

The accommodations consist of a midship deckhouse on the bridge deck for the captain's stateroom and spare room, with a pilot house over; the saloon, officers' and petty officers' berths, pantry, toilet, etc., are in the bridge; the engineers', cooks', steward's messroom, refrigerator, toilets, galley, etc., are in the house on the poop deck, and the oilers, seamen and firemen are berthed in the poop abreast the engine casing.

Deck and Propelling Machinery

A steam windlass is fitted forward with the wildcats and warping ends on the forecastle deck and the engine below in the forecastle. A steam capstan is fitted on the after end of the poop deck, with the engine below. The steam steering gear is fitted on the upper deck abaft the engine casing with connection to the steering stations in the pilot house and on the navigating bridge; an auxiliary hand screw gear being fitted to the crosshead on the rudder stock on the upper deck.

The propelling machinery is placed aft and consists of one triple-expansion inverted reciprocating engine of about 2100 indicated horsepower and two single-ended Scotch boilers have a working pressure of 185 pounds.

The vessel is intended for the coastwise coal-carrying trade. Loading and discharging gear is not fitted on board, the two terminal points being arranged with these facilities. The vessel was launched Dec. 15.

Power Limitations of the Marine Gasolene (Petrol) Engine

BY ALBERT H. ZIEGLER

An investigation of several of the largest sizes of gasolene (petrol) marine engines ever built and installed in America, produces abundant evidence of almost infinite careful attention in every detail to all the conditions and functions affecting maximum efficiency and low fuel consumption, and indicates that after having had about ten or twelve years of practical experience in the application of the larger sea-going, heavy-duty gasolene (petrol) engines to the mercantile, yachting and high-speed naval fields, America has produced a type of engine which to-day represents, in all probability, the maximum aggregate of all the important practical advantages and operating qualifications over steam installations that may ever be looked forward to in any marine engine consuming so costly a fuel as gasolene (petrol). As regards any further material reduction of fuel consumption per brake-horsepower per hour, present achievements along such lines in the properly designed and constructed modern gasolene (petrol) marine engine leave little or nothing to be hoped for.

The engines investigated were of the double-acting type, the total percentage of mechanical friction loss per unit of power delivered to the shaft being considerably less, and the mechanical efficiency being therefore higher than is the case in single-acting marine engines. The delivered or shaft-horsepower of the engines considered was about 89 percent of the indicated horsepower at full load.

In these engines the compression was 84 pounds gage pressure, all that a marine engine of their size, operating at full load practically all of the time, under medium heavy-duty conditions could stand, to insure reliability of operation, freedom from overheated valves, and pre-ignition. The piston-speed was 750 feet per minute.

All inlet valves and valve passage areas were sufficiently large, and of such form as to secure the admission of the carburetted charge at a full load inlet pipe vacuum not exceeding one-half pound gage pressure, thus relieving the pistons from acting against any unnecessary retarding vacuum during the whole of each suction stroke, work that, once done, is never regained nor justified in any gasolene (petrol) engine.

The charges were taken into the cylinders at a temperature considerably lower than that of the outside air, due to the refrigerating effect of the evaporation of the gasolene (petrol), insuring a contracted or denser charge. This, together with the very slight attentuation of the incoming charges, due to the unusually low inlet pipe vacuum, insured a remarkably high volumetric efficiency in the cylinders, a very large charge of high density, and producing a high mean effective pressure, therefore requiring a proportionately smaller engine for producing the required power, with less friction loss than a higher degree of inlet pipe vacuum and a heated and expanded charge would have occasioned.

The lessened velocity and fluid friction of the incoming gases, due to the large areas, carefully designed passage forms and the low in-take pipe vacuum, also aided materially in the high degree of efficiency attained. The exhaust valves and passages were of the same areas as for the in-take.

A large exhaust manifold, having an internal diameter almost equal to the cylinder diameter and long enough over all to include all cylinders, forming in effect a large exhaust expansion chamber, was placed within a few inches of all exhaust valve seats. All cylinders exhausted into this chamber, one at a time, in their proper sequence, the ends of all exhaust passages projecting into the chamber in the form of hoods or cowls, and so arranged as to cause the high-pressure, high-velocity gases of any one cylinder, the exhaust valve of which was just beginning to open, to set up a strong ejector action on the hood of the previously exhausting cylinder, the exhaust valve of which was nearly closed. This ejector action not only positively relieved all back pressure on the pistons during the exhaust stroke in all cylinders, but also set up within the cylinders a slight degree of vacuum which, acting on the next incoming charge, helped overcome the inertia due to starting the gas to flow into the cylinders, and resulted in a somewhat increased volumetric efficiency, higher mean effective pressure, and therefore higher mechanical efficiency. The exhaust pipe from this manifold to the outside air was of such a diameter as to produce a mean gas velocity through it of not over 70 feet per second.

The carburetor was of special design, operating uniformly at the one-half-pound vacuum, from no load to full load, and securing a most thorough atomization of all gasolene (petrol) passing through a nest of nozzles or spray tubes, this finely sprayed gasolene (petrol) being very intimately intermixed with the incoming air charges, and the in-take pipe above the carburetor being sufficiently hot-water jacketed to prevent the condensation of the gasolene (petrol) vapor on the walls of the inlet pipe and passages, but not appreciably heating the center of the charge. The mixture was run very lean, being only rich enough to prevent back-firing through the inlet pipe and carburetor.

Double ignition in each cylinder, both sparking exactly simultaneously at all speeds, was employed, the plugs giving an extra large and "fat" arc flame, which combined features secured very rapid flame propagation and reduced the ignition lead required at full load, high speed, to less than 16 degrees.

During the fuel consumption tests the engines were run at maximum load, and the cooling water was heated to 165 degrees F. The crankshaft was made to allow a constant circulation of cold water throughout its entire length, and all bearings on the engine were given an abundant supply of oil. Though the expanse of water-jacketed surface in the combustion spaces was rather generous, it was found on actual test and comparison that a sufficient increase of compression was thereby obtained to more than offset the slightly excessive water-jacket heat losses.

The final result of the above refinements in these engines is a strong indication that it would be impractical to expect, under ordinary conditions of operation, and with the grades of gasolene (petrol) now commercially available in large quanti-

ties, a lower fuel consumption for marine engines than was obtained in these instances; namely, .1124 gallon, or .9 pint, or by weight, .64 pound of gasolene (petrol), of about .683 specific gravity, 75 degrees Baumé (weighing 5.69 pounds per gallon) per brake-horsepower.

The modern large marine gasolene (petrol) engine, such as above described, for application in the workaday mercantile, yachting and high-speed naval craft, if fuel cost is not considered, has proved its many practical advantages over steam installations as regards total first cost, weight involved, space required, and simplicity of propelling machinery with its auxiliaries and accessories, making necessary therefore either a smaller hull requiring less power to drive it at any definite speed and for a definite accommodation capacity, or else producing a higher speed with greater space available for cargo or passenger accommodations in any definite sized hull. The engine rooms are cooler and fresher, there are no fiery stokeholds, refueling is infinitely easier, cleaner, quieter and more quickly accomplished. The cruising radius is about doubled for a definite weight of fuel supply, practically no time is required for preparations for getting under way or for laying up after a run, no fuel is consumed when the boat is not running, there is no banking of the fires to be attended to, no government boiler inspection, no boiler scale and flue cleaning; also there is a considerable reduction in the crew required, as well as in the involved crew's quarters, wages and feeding requirements.

Such engines have also proved their general reliability of operation, proper adaptability, flexibility of speed and power control, accessibility for inspection and repair, long life and direct reversibility, without recourse to planetary reverse gearing. They are also capable of starting and stopping almost instantaneously in either the ahead or the astern motion, and as many times in succession as may be required in maneuvering about any crowded harbor.

Though a very great deal still remains to be done regarding lessening of the cost of production, simplification of mechanical detail, standardization of design and construction, consistent with each class of marine service, and in disseminating a more thorough appreciation and knowledge of the importance of a more rigid adherence to a policy absolutely requiring a correct selection of the proper weight, rotative speed and type of engine for each class of marine service, yet the future developments of the internal-combustion marine engine are likely to do very little, in America at least, toward bringing about the ultimate general adoption in the larger sizes of that form of propelling engine in preference to the steam installation properly equipped, until internal-combustion marine engines are eminently able to operate on a very much cheaper and more abundant supply of fuel than gasolene (petrol).

An investigation of the performances of such sizes and types of gasolene (petrol) engines as are more or less common to the heavy-duty, deep-sea class of marine service in American waters, covering both the builder's test-stand records and the log records of various types and tonnages of craft where such engines are installed, produces the following mean results as to gasolene (petrol) consumption and fuel cost per brake-horsepower per hour, the gasolene (petrol) used being 68 degrees Baumé, .707 specific gravity, weighing 5.81 pounds per gallon, and costing 11 cents (0/5½) per gallon in 500-gallon lots in and around New York Bay:

Per B. H. P. Hour	75 H. P.	150 H. P.	300 H. P.	700 H. P. Double Act'g
Gallons	.1225	.1210	.1200	.1125
Pints	.981	.970	.962	.900
Pounds	.722	.714	.707	.664
Cost	1.347c.	1.33c.	1.32c.	1.237c.
	.674d.	.67d.	.66d.	.610d.

From which it is evident that the fuel cost per brake-horsepower-hour does not vary much for large and small-sized units.

For the same fuel costs per brake-horsepower-hour, coal at $3.25 (13/6½) per ton of 2,000 pounds, steam installations of similar powers would have to consume coal to the following amounts:

Per B. H. P. Hour	75 H. P.	150 H. P.	300 H. P.	700 H. P.
Cost	1.347c.	1.33c.	1.32c.	1.237c.
	.674d.	.67d.	.66d.	.619d.
Pounds used	8.3	8.18	8.12	7.61

In most representative practice the consumption of coal per brake-horsepower-hour for steam installations of like powers, with the auxiliaries and equipment commonly found in each case, is at full load as follows:

Per B. H. P. Hour	75 H. P.	150 H. P.	300 H. P.	700 H. P.
Pounds used	10	6	3	2
Cost	1.625c.	.976c.	.488c.	.325c.
	.613d.	.488d.	.244d.	.163d.

From the above it is evident that the fuel cost of steam installations drops rapidly as the size of the installation is increased and proper auxiliaries added, and that gasolene (petrol) as a fuel would cease to compete with coal in installations of from about 90 to 100-horsepower output, and over, were the cost of fuel per brake-horsepower-hour the only important factor.

The deciding factor for determining the proper power limitations for gasolene (petrol) installations for each class of marine service, however, is the result of a comparison of the total costs of operation and upkeep, covering a year or more, per ton-mile traveled at any definite speed, for both the gasolene (petrol) and the steam installations. After having considered the reduction in total operating expenses made possible by the gasolene (petrol) installation, because of its somewhat lower first cost, lighter weight, smaller bulk, increased cargo space made available, greater cruising radius, smaller hull required, absence of stand-by fuel losses, reduction in crew's wages, quarters and feeding accommodations and cost, etc., it is proved in actual practice that gasolene (petrol) engines of considerably higher output than 100 horsepower are justifiable. The economical limit for gasolene (petrol) installations in the mercantile marine class of service has thus far proven in innumerable instances to be in the neighborhood of 200 horsepower; for cruising yachts not over 300 horsepower; while in high-speed naval work gasolene (petrol) installations up to 1,400 horsepower have been made and have been found justifiable. The internal-combustion marine engine industry is being forcibly convinced of the fact that beyond these limits of powering the larger sizes of gasolene (petrol) marine engines can have very scanty prospects of an active future; the high and steadily rising price of gasolene (petrol), also the limited supply in sight, rendering all the other practical advantages and operating qualifications of such engines of little or no value in competition with steam installations.

The qualities rendering the internal-combustion engine so peculiarly adaptable to marine work are too real and important to permit the restriction of such engines to the smaller installations only, the field for application of which, as above quoted, is a mere tithe of that which would immediately become profitably available to any type of engine which could burn the cheaper, heavier oil fuels, and which would involve as little carbonization, sticking of pistons and rings, fouling of igniters, self and pre-ignition, overheating, smoking exhausts, having as great flexibility of speed and power control, approximately the same fuel consumption in pounds per brake-horsepower-hour, which would not necessitate the carrying of any fresh water supply for use in the cylinders along with the fuel, and which could operate with as high a degree of success as is now attained with the internal-combustion engine that burns commercial gasolene (petrol).

With abundant quantities of good grades of oil fuels of 28 degrees Baumé, .886 specific gravity and lighter, available at from 2 to 3 cents (0/1 to 0/1½) per gallon, whereas gasolene (petrol), bought in large quantities, costs from 11 cents (0/5½) per gallon for the cheaper and heavier grades to 18 cents (0/9) and more for the lighter and more volatile qualities, the one great objection to the very large internal-combustion engine would be removed, provided such engines were available to operate on oil fuels.

Though America generally prides itself upon its initiative and enterprise, in many of its productive industries it is, commercially, most conservative. Capital in this country will get behind an industry and make its greater development possible only after a superabundance of proof exists that such an industry is really a most profitable investment. European capital for industrial investment is to an appreciable degree more liable to accept the chances coincident to discovering its own profitable fields for investment before such fields are very thoroughly developed; for the sake of the opportunity of securing the exclusive rights perhaps, but resulting in many instances in an unmistakable and important lead over American enterprise. This condition of mind is perhaps best exemplified in the large marine oil engine building trades, European builders having installed many hundreds of units of over 1,000 horsepower output, some being multi-cylinder installations producing as high as 2,000 horsepower in one double-acting cylinder. Even Russia, a country which many Americans appear to have believed rather behind in engine constructions of note, five or six years ago built and installed many very creditable marine oil engines in units of 800 horsepower and over, whereas America, so far, has made very little practical showing in marine oil engines of even 500 horsepower, the construction of the first American 800-horsepower unit having been attempted only this year.

Recalling that by far the greater part of the world's oil supply is produced in America, and that the present state of development of the American marine gasolene (petrol) engine is second to that in no other country in the world, it is difficult to attribute America's comparatively small showing in the larger strictly oil marine engine to any other cause than the reluctance of the American engine building investor of capital to risk his finances until it has been abundantly and thoroughly proved to his satisfaction that the problems involved in the successful marine oil engine for deep sea-going ships have been thoroughly solved—by other investors.

Proposed Standard Sizes of Catalogues.—As a result of a thorough investigation by a committee of the Technical Publicity Association of New York, a movement has been inaugurated to secure uniformity in the size of catalogues. The committee recommends 6 by 9 inches and 8½ by 11 inches as the standard sizes of catalogues for all purposes. The committee also recommends 8 by 10½ inches as the size for bulletins. The recommendations of the Technical Publicity Association agree in all respects with the reports of similar committees appointed by the American Society of Mechanical Engineers and the American Institute of Architects, except that these committees recommend the 8½ by 11-inch size for both bulletins and catalogues. It is hoped that all manufacturers will adopt these standards for all future catalogues and bulletins.

Thornycroft 40-Foot Cabin Launch.—Messrs. John I. Thornycroft & Company, Ltd., recently completed for the Brazilian Government a cabin launch 40 feet long, 7 feet 6 inches beam and 3 feet 9 inches molded depth to be used by the Admiralty for the port of Rio de Janeiro. The engine is of the Thornycroft "N" type with six cylinders, developing 52-brake-horsepower, driving a three-bladed propeller at 1,180 revolutions per minute and giving the launch a speed of 15½ miles per hour.

On the Possibility of Building a Large Passenger Liner that Would Not Under Any of the Known Mishaps at Sea Lose Her Buoyancy or Stability and Sink*

BY GEORGE W. DICKIE

This problem has occupied the minds of many, if not all, prominent naval architects since the disaster that overtook the *Titanic* in 1912. A great deal of legislation followed this calamity, nearly all of which dealt with means of escape for everyone on board a sinking ship. In a smooth sea and with all conditions favorable it might be possible to handle and load 80 or 90 boats, and, if they could remain in the vicinity of the disaster and intelligence had reached other ships within a radius of 200 miles, a large proportion or perhaps all of these boats might be picked up. In order that this condition be possible, however, we must assume exceptional conditions.

I am writing this paper on board the *Congress,* a new vessel on her maiden voyage from Philadelphia to San Francisco. This vessel was designed by myself for the passenger and freight service on the Pacific Coast and is to run between Seattle and San Diego, the principal stops en route being San Francisco and San Pedro, the port of Los Angeles. Changes in the laws relative to life-saving apparatus added about 25 tons to the designed weight to be carried on the boat deck of the *Congress,* and, in order to maintain the designed stability, I had to increase her beam from 53 feet to 54 feet 9 inches, the boats being carried 35 feet above the load line. With a full passenger list this vessel carries 850 people, and, should it ever be necessary that they leave the ship during that part of her voyage north of San Francisco, I can hardly conceive of its being accomplished without serious loss of life. The ship itself, even with half the freeboard gone, would be so much safer and more comfortable than small boats or rafts that it is worth much thought, careful planning, some compromises and considerable money to accomplish the design of a hull which would not lose its buoyancy or stability when subjected to the known disasters of the sea and which at the same time would not be open to any serious financial or commercial objections.

The question of designing a ship that cannot be sunk by any of the known accidents which befall vessels at sea cannot be treated in a general way. The conditions are so varying in different types of vessels that the only way to handle the subject is to assume a certain type and work out the problem in its relation to the assumption, which is what I propose doing in this paper. I have taken a typical large passenger steamer of the following dimensions:

Length between perpendiculars	800 feet
Beam, molded	90 feet
Draft, loaded	33 feet

With a coefficient of .64, these dimensions would give a load displacement of 42,130 tons. There would be a complete double bottom, the inner shell being 4 feet from the outer skin, extending from the fore peak to the after peak and up the sides to the lower deck, which would be 15 feet above the base line. The main deck would be 9 feet above the lower deck and the upper deck 9 feet above the main deck amidships and would extend parallel to the base line from frame 87 to frame 233. From frame 87 to the stem this deck would slope down, touching the stem at a height of 26 feet above base, and from frame 233 it would slope downwards aft, touching the stern

* A paper read before the Society of Naval Architects and Marine Engineers, New York, December, 1913.

frame at a height of 27 feet. There would be 12 bulkheads extending from the inner bottom to the upper deck. These would be absolutely watertight, without doors or openings whatever, and would be spaced as follows, the frame spacing being 30 inches: No. 1, fore peak, frame 24; No. 2, frame 45; No. 3, frame 66; No. 4, frame 87; No. 5, frame 116; No. 6, frame 145; No. 7, frame 174; No. 8, frame 203; No. 9, frame 233; No. 10, frame 254; No. 11, frame 275; No. 12, the after peak bulkhead; the double bottom space being divided in the same manner. As the horsepower of such a vessel would not be less than 45,000, the boiler compartments and coal bunkers would, to a large extent, control the subdivision, and it will be noticed that I have provided four main boiler compartments, each 72 feet 6 inches in length. Each compartment is intended to take four double-ended Scotch boilers abreast, these to be 17 feet in diameter and with 8 furnaces each, giving 128 furnaces in all, or 2,800 feet of grate surface to develop 16 horsepower per foot, which would be easy with forced combustion. It will be noticed that the boiler compartments have a bulkhead at each end 16 feet from the main bulkhead. These bulkheads extend to the inner bottom and skin of the ship and are built strong enough to support the wall of coal between them and the main bulkhead. These would each have 4 coal bunker doors, one opposite each boiler. Each bunker holds 750 tons, and as there are 8 of them the coaling capacity would be 6,000 tons, all of which runs out directly in front of the boiler it is to serve. These bunkers would be filled from either side through side doors 3 feet 6 inches square with triangular side pieces forming hoppers when open, thus insuring quick coaling. The amount of coal provided is sufficient for eight days' steaming at 45,000 horsepower.

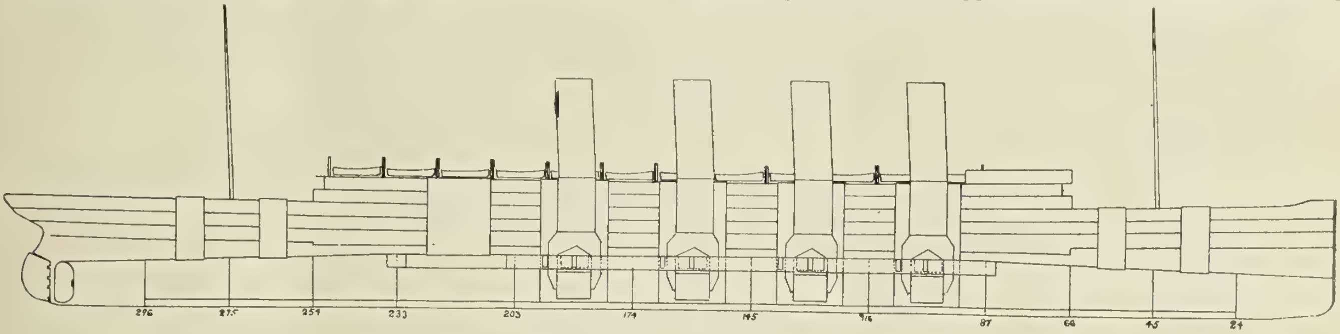

Fig. 1.—Design of Unsinkable Ship Proposed by Mr. Dickie

I think it will be admitted that this ship could be considered safe from any injury to the bottom below the lower deck and that danger of sinking would arise from rupture of the skin above the lower deck and under the waterline, which is at the upper deck line. Such danger would arise from collision with another ship at such an angle as would cause penetration or through striking some stationary mass between the lower and upper decks, opening up several compartments to the sea as in the case of the *Titanic*.

Let us first consider penetration by collision. Here the damage would be vertical and might, if the striking vessel were large and nearly at right angles, penetrate quite a distance into the side of the vessel. I think, however, that such a disaster could not entail more than three adjacent compartments if near amidships, or say 219 feet 6 inches. What would be the condition with three adjacent compartments near the center of this vessel flooded? The capacity of one of these compartments would be 163,345 cubic feet, from which would have to be deducted the displacement of the boilers, less furnaces, tubes and combustion chambers, or 13,120 cubic feet. The coal capacity would also have to be deducted, for if half the coal were used the vessel would be 3,000 tons lighter, and if the coal were all on board it would displace so much water, and for this we must deduct 52,000 cubic feet and also 1,740 cubic feet for a central watertight passage under the upper deck. This leaves 98,225 cubic feet, or 2,806 tons for each of the three compartments that we consider may be possibly injured through collision, or 8,418 tons to be carried by new displacement. In order to provide the displacement for the condition described above, I would propose to fit what I would term a double upper deck, the upper member of which would be 5 feet 6 inches above the lower amidships and parallel to the base line between frames 66 and 254, at which frames it would rise 2 feet and follow the shear line to the stem and stern. In case of a collision cutting into the upper member of the upper deck, the local damage would be confined practically to the depth of penetration and the width of the striking ship, as the space between these decks would be divided into very small compartments both transversely and longitudinally. As it is, we have between these upper decks 9,730 tons of displacement, which, in case of three compartments being opened to the sea, would leave the upper member still materially above the waterline. If the injury was near the forward end of the ship, the lower member of the upper deck extending downwards reduces the size of the flooded compartments and the displacement of the contents of the holds, at least 50 percent would still further have to be deducted, while the upper member rising at frame 266 and following the shear line would provide sufficient displacement to trim ship till water could be introduced into the double bottom aft. These same conditions would apply in case of serious injury aft. It will be understood, of course, that all openings through the upper deck, such as boiler and engine casings and hold hatches, would be watertight structures for at least 16 feet above the load waterline.

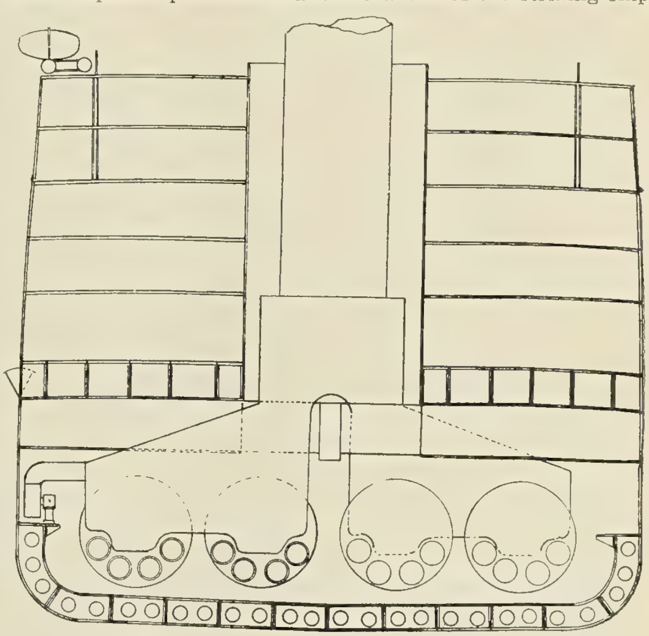

Fig. 2.—Section Through Boiler Space

We come now to another form of disaster, the ripping open of the side of a ship for a considerable proportion of her length by striking the projecting edge of some obstruction under the waterline. In the case under consideration this might happen between the lower and the upper deck for a great portion of the vessel's length. The five large compartments would add 14,030 tons to the displacement, while the forward holds, assuming that the cargo occupied one-half the space, would add 3,800 tons more, and the after compartments, if they had to be flooded to trim ship, would add 3,400 tons, a total of 21,000 tons. This would sink the vessel 11.86 feet, or 6.36 feet above the upper member of the upper deck amidships, and she would then draw 43.86 feet. This assumption is to the very limit of the possibilities, yet, for an unsinkable ship, it should be provided against in the design. Between the upper member of the upper deck and the shelter deck there should be no air pores or side lights, or if lights are fitted they should not be arranged to open and the glass should be cast around a wire mesh as a protection against cracking.

The objection that would naturally present itself to this type of vessel is the apparent waste of space between the upper decks. This space, however, need not be wasted. Forward of frame 66 this space is 7 feet 6 inches high, increasing to 12 feet at the stem, and could be utilized to receive stores of all kinds, the compartments being only open at certain hours for issuing the day's supplies. The space from frame 254 aft, starting at 7 feet 6 inches and increasing to about 12 feet in height, could be divided into cold storage compartments for all the different kinds of provisions. The space amidships, 5 feet 6 inches high, would form the sub-basement for the hotel part of the ship above. All ventilating ducts, salt and fresh water mains and drainage pipes would be arranged in this space so that only vertical piping would be carried to the rooms. This grouping of all piping and ducts which run horizontally would save much trouble both in the design and working qualities of these systems. This I consider a very important feature in such a design. One of the hardest problems the designer has to face is dealing with pipes and ducts through living quarters and it is always the horizontal pipes that give trouble. By having the mains of these systems between the upper decks where they are accessible at all times without the passenger knowing anything about them, a continued source of dreaded trouble is removed, and furthermore this would not interfere with the proper subdivision of the space.

Referring to the cross-section through one of the boiler compartments, it will be observed that I have provided a longitudinal passage under the upper deck. This passage would be extended through each compartment, from which it would be entered through an air lock and it would extend from frame 87 to frame 233. In each boiler compartment on each side would be the living quarters for all the men engaged in that compartment. These quarters would be artificially lighted and ventilated. The air would be taken from ducts between the upper decks on the inboard side, discharge at the floor line, and would pass up through ventilating pipes on the outboard side. It might be objected that these quarters would be hot in spite of good ventilation. In this connection I consider it quite unnecessary to have much heat in the boiler rooms. The boilers in such a ship would be worked under forced combustion and in that case the fans for forced draft could draw the air from the outer casing round the smoke stack and upstakes and discharge it into a casing outside the boiler lagging so arranged that the air would circulate round the boilers on its way to the tubular heaters in the upstakes. Thus any heat radiating through the lagging on the boilers would be taken up by the air for combustion, leaving the firerooms comfortably cool, and with cold air freely circulated through the living quarters they should be quite comfortable.

The air lock doors into the central passage would be self-closing, balanced doors, easy enough for a man to open, but certain to close after him, and it would hardly be possible to conceive of any damage to this passage even from a collision with a very large ship. At both ends of this passageway would be stairs in a watertight well leading to the shelter deck.

The compartment forward of the forward boiler compartment would contain the main ventilating fans with cooling and heating chambers for the air. These ventilating fans would be supplied from trunks extending well above the weather deck and their capacity would be such as to insure thorough ventilation throughout the ship. The compartment aft of the main engine-room would be the electric generating room, where a sufficient generating plant would be installed to insure perfect lighting, heating and ventilation.

I have not, of course, tried to work out all the details for such a ship. What I have done is intended to be suggestive. A vessel built to carry out correctly such a suggestion would, I am sure, be practically an unsinkable ship and, with all her fire mains controlled from the interior of the upper deck, it would hardly be possible for a fire to gain great headway. We have just heard by wireless that a fire had broken out on the *Imperator* in New York harbor. This would indicate another form of possible disaster to the great modern passenger liner. The double upper deck would offer many advantages in case of fire. The fire mains, probably six in number, would all be installed between these decks and vertical pipes from these mains would extend up to every room, in size and number proportionate to the size of the room. By means of these numerous rising pipes, any room in the ship could be immediately drenched with water and these pipes could be arranged to be operated either from the room where the fire occurred or from between the upper decks. By this means water would be applied only where there was fire and no damage would result outside of the place where the fire started. As a fire could not possibly occur between the upper decks and as this space is well ventilated, no part of the ship would be beyond direct control of the fire mains and much of the unsightly attachments for fire hose in the living quarters could be done away with.

With a vessel so constructed would it be necessary to carry the great load of boats and gear for handling them that, under present conditions, is considered so necessary?

Obituary

Herman Charles Meinholtz, vice-president of the Heine Safety Boiler Company, died at St. Louis, Mo., Dec. 24, at the age of 45. Mr. Meinholtz entered the employ of the Heine Safety Boiler Company at the age of nineteen as a draftsman, and was continuously connected with that company up to the time of his death. He was made superintendent in 1895 and vice-president in 1907. He had entire charge of the company's shop when it was established in 1899, and under his general direction the company's new factory was designed and built in 1909, and since that time it has been under his direct supervision. Mr. Meinholtz was a member of the Engineers' Club of St. Louis and of the American Society of Mechanical Engineers.

Jordan M. Fritzius, aged 78, prominent for sixty years in the industrial life of the lower Monongahela River Valley, died in Pittsburg Jan. 14. He began the boat building business when 16 years old, and remained actively in this business through all its devlopments until he retired a year ago. In the early days the timber with which he constructed boats was cut at points up the Allegheny and Monongahela Rivers and floated down in great rafts. When he retired Mr. Fritzius was building steel barges and steel hulls for steamers used in the rivers of South America. For many years he was closely associated with the late Col. W. R. Jones at the Edgar Thomson Steel Works in Duquesne.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER*

CHAPTER XIX

Care and Management of Engines and Auxiliaries

The *Tuscarora* arrived in New York and was loaded for her first trip South after the extensive repairs she had undergone. The chief had, of course, been so busy attending to getting the vessel's stores, etc., ready for her regular trips that he had paid no attention to his class other than to caution them to keep on with their studies and to learn as much as they could from observation, keeping in mind what he had told them about the various parts of the machinery.

There was a new second assistant by the name of Davis on board, and he had been placed in charge of the boilers. Coming into the fire-room suddenly one day he found O'Rourke delivering a lecture to a couple of coal passers on how steam was generated. "This blatant heat," he was saying, "is what makes you fellows hustle out the coal; it's like shoveling snow in the East River to make the tide rise; you don't seem to get a run for your money until all of a sudden—'biffo,' the steam shows on the gage!"

Davis could stand it no longer, and said, "Cut that out, O'Rourke, and get down to work—what do you know about steam, anyhow?" This highly incensed the shining light of the Floating School, and he replied rather impudently that he "was only trying to give these ginks a little scientfic dope." Later in the day O'Rourke complained to the chief that the second assistant had cut short his efforts at enlightening the coal passers on matters he had learned at the school, but he was told to pay more attention to his work and not to bother with imparting his knowledge to an unappreciative audience.

The ship sailed from New York at her scheduled time, and was soon bucking into a southeaster as she headed down the coast. It cleared off the next day, and as everything was working smoothly the chief rounded up his class that afternoon, all of them being off watch, and proceeded to give them some further instruction.

He began his remarks by saying that it was a most unusual thing for a chief engineer of a vessel to take time while his vessel was underway to be holding a school for his men, but as he had only a little further to go in his remarks he was determined to finish the job up, even if he did have to defy all precedents.

"Having told you something about the care and management of boilers, I propose this afternoon to give you some hints on the care and management of the main engine and the various auxiliaries in the engine room.

"An engineer standing a watch at sea has so many things to attend to that to enumerate them all would fill a book in itself. Probably no other business requires so much alertness and quick acting and thinking as a marine engineer is called upon to do in the proper performance of his duties. Every faculty which God has given him is called into use. Unlike locomotive and stationary engineers, he must never allow his engines to stop for days and days at a stretch. A locomotive will be driven for five or six hours and then run into a roundhouse for a rest; a stationary engine will be run for ten or twelve hours and then stopped; but it is very seldom that a marine engine is ever stopped or even slowed down in a voyage lasting very often a week, or even two weeks at a time. To do this successfully requires the highest degree of skill, and above all things the closest attention to even the most minute details, as the derangement of even a very small part of an engine often results in a serious breakdown at a critical moment. Remember, young men, that to be successful in your business as an engineer there is no detail about the entire mechanism of a ship that is too trivial to demand your closest attention.

"Preparations for getting underway for a long trip at sea should begin early in the morning of sailing day. If repairs or adjustments have been made during the stay in port, the engineer should personally see that every set-screw on the moving parts is set up tight; that all the bearings have been oiled around by hand; that all oil cups are filled; that the sight-feeds are properly adjusted and in working condition. To make sure that all parts of the main engine are clear, it is well to turn the engine at least once clear around, either by hand or with the jacking engine. After this is done he should personally see that the worm of the turning gear is thrown out of gear; failure to do this has cost many a man his job.

"The first thing to do is to start the circulating pump slowly and get the condenser cooled off and ready for the exhaust steam. An hour or more before time to start, depending upon the size of the engine, steam should be admitted slowly to the steam jackets around the cylinders, if there are any, if not steam can be let into the cylinders direct by cracking the throttle slightly and opening the by-pass valves. All drain valves from cylinders and valve chests must be kept open to the condenser, as steam striking the cold cylinder walls is immediately turned into water, and should be allowed to drain into the condenser.

"The warming up of large iron castings must be done slowly and thoroughly—never make haste in this process unless in a great emergency. After the cylinders are too hot to bear your hand on them, and having ascertained from the people on deck that sufficient mooring lines are out, steam may be admitted to the engine very slowly at first, and the turns gradually increased to not more than half-speed. The reversing engine should be tried back and forth a number of times to see that it works satisfactorily, and to see that the main engine will run well in the backing gear. The water service should be started. The drain valves should be kept partly open all the time that the engine is being warmed up, and, in fact, they should not be closed altogether until the vessel is underway from the dock for at least ten or fifteen minutes.

"Before sailing the chief engineer has, of course, satisfied himself that all necessary stores are on board; that the oil tanks are filled up, and that all wrenches and other tools for making quick repairs or adjustments are in place and easy of access.

"Everything now being ready, and the captain advised of that fact, the engineer stands by the throttle, posts a man at the engine-room telegraph, which has been previously tried and found to work satisfactorily, and awaits the starting signal. All signals from deck must be answered promptly, as in working away from the dock and through the crowded harbor any delay whatsoever in quickly working the engine as directed would be dangerous. Full speed is seldom ordered until the vessel is well clear of the harbor, but when it is rung up the throttle should be opened only to such an extent that the engine will just use up all the steam that the boilers will make, and will maintain a uniform number of revolutions. Fluctuations of the steam pressure should be avoided as much as possible, and so far as he is able the engineer on duty should strive to carry uniform boiler pressure, revolutions and vacuum.

* Engineer-in-chief, U. S. Revenue Cutter Service.

"The first few hours of a run the man on watch should be unusually alert in feeling bearings, especially those which may have been recently adjusted, in order to detect the first sign of unusual heat. When a bearing starts to warm up it gets 'red hot,' as the saying is, in very short order, and should be given instant attention. The causes of hot bearings are in most cases due to being set up too tight or else from insufficient oil supply. Occasionally heating is due to the presence of grit, but that can only result from rank carelessness in not having the bearings sufficiently covered up or otherwise protected when the engine is not in use."

"How do you cool a hot journal without stopping the engine?" inquired Nelson.

"Put cold water on her, of course, the same as you would cure a headache," volunteered O'Rourke.

"That's the very last thing you should do," continued the chief. "The first thing is to give it a large dose of oil, and in nine cases out of ten you will find that it will gradually cool off from that treatment. If it persists in heating up after you are sure that it is getting plenty of oil get out the proper wrenches and slack off the nuts a trifle. This generally accomplishes the object sought, but if even that method fails then resort to the water service, as sparingly as possible, but just enough to keep down the heat. If the ship was running in fresh water the effect would not be so bad, but salt water on a bright journal is harmful."

"I get you, chief," broke in the effervescing O'Rourke. "Curing a hot bearing is just like curing a man of a stomach ache. If it isn't very bad give him a dose of castor oil; if it gets worse put on a mustard plaster; if that don't work give him an injection of fresh water, not salt, as that would hurt him."

"Your powers of comparison are certainly well developed, O'Rourke, but I fail to see the similarity between slackening up a bearing and putting on a mustard plaster."

"Well, if that mustard plaster attends to its business all right the man will want to slack it up, you can bet."

"Chief, will you please give us some points on oiling," suggested Pierce, who was feeling the responsibility of his new job.

"I was just coming to that important subject," replied the instructor. "Oiling, like water tending, is a very important job on board ship. Although people refer in a slurring manner to the 'greasers' there are few jobs anywhere which have the importance of a marine oiler. A little inattention to his duties may result in doing great damage to the machinery, and may even stop or cripple the ship. An oiler in his rounds must be as regular as clock work, and constantly on the alert with his senses of feeling, hearing, seeing and even smelling. To a trained oiler all these senses come into play. By feeling of revolving crankpins, eccentric straps, main journals, etc., with his hands he can tell instantly if any of them are overheated, or even if they show a tendency to heat. To his sensitive ear the first discordant noise, even the slightest squeak, will indicate that some bearing or journal is running dry and needs immediate attention. His eyes must be sufficiently keen of vision to see minute and almost invisible drops of oil passing down the tubes of automatic oilers, and at times to discern even the slightest sign of smoke, which would indicate an overheated bearing. His sense of smell is called into play to detect the first indication of overheated oil or grease."

"What about his sense of humor," inquired Schmidt.

"Every oiler must have that sense well developed also, as his main object is to prevent any squeaks or groans from the bearings under his charge.

"In giving advice to you on oiling I want first to warn you against putting too much dependence on automatic oiling gear of any kind. Such apparatus is all right when it works well, and I must say that it does work well for 99 percent of the time; but there is always that small percentage of the time when it does not work well that you must guard against. A change in the temperature of the air surrounding a needle valve on oil reservoirs will often change the adjustment of the drip, so that the bearing to which it directs the flow of oil will not receive a sufficient quantity and become heated. The same trouble might be started by a small speck of dirt or grit getting under the valve. Therefore these contrivances must be given very close attention.

"Many engineers prefer the old-fashioned wick feeds, as they are much more positive in their action, although not quite so easily adjusted.

"Most oilers, and especially beginners, use entirely too much oil, both from oiling by hand and from the automatic feeds. However, this tendency is quite easily regulated by the system of putting every man on an allowance for his watch. The good oiler usually finds his allowance to be ample, whereas the negligent man and the inexperienced man have to hustle to keep things running cool on the amount given them.

"A routine should be established, the time between oilings being regulated to suit the speed of the engine and the necessity for the oil. Usually crankpins and eccentric straps should be oiled by hand once each twenty minutes; the main journals, link gear, etc., once each half hour. An inspection of the thrust bearing, spring bearings and stern tube gland once each half hour is usually sufficient. Piston rods and valve stems should be swabbed every half hour, but as little oil as possible should be used each time, as it is by this means that oil gets inside the cylinders, is carried into the condenser and then pumped into the boilers. This is an evil that must be guarded against as much as possible.

"On many modern ships no oil whatever is used to lubricate the main engine pistons and valves; if any lubricant is necessary many engineers use graphite mixed with water. As a matter of fact in engines using piston valves, internal lubrication is not absolutely necessary. The cylinder walls are always at a less temperature than the entering steam; consequently some of the steam is condensed, and the water formed by this condensation acts as a lubricant.

"On the smaller engines, used as auxiliaries, such as pumps, blowers and dynamos, internal lubrication seems to be more of a necessity, and it is by this means that oil gets into the feed water and later into the boilers. The introduction of the steam turbine for driving dynamos and pumps does away with this danger, as, of course, no oil is necessary for the interior of turbines.

"Many engineers prefer to use grease, or compound, as it is termed, on small journals, and on those which have but little friction. Cups, known as compression cups, are screwed to the caps of such journals, and the oiler, by simply giving a small twist to the screw top on the cup, forces enough grease on the journal to last sometimes for several hours. Some engineers use grease for thrust bearings and tunnel bearings, but it is more economical to use oil. On well-designed thrusts the collars on the shafts are made to run in a bath of oil, which is kept cool by salt water circulated through coils in the bottom of the bearing.

"Oil should be caught in the drip-pans and passed through oil filters, of which there are several good types on the market, after which it can be used over again.

"It takes experience to make a good oiler, but, of course, you cannot get the experience without actually doing the oiling. In your first attempts you will do well if you only take the bark off your knuckles, and perhaps lose a finger nail, while feeling the crankpins and eccentric straps. This is a very important part of his duties and can be learned only by practice. One good rule to remember is never to feel a rapidly-revolving piece of machinery that is running toward you; wait until it starts to go away from you and then feel it very quickly. No day-dreamer can be successful, as feeling of crankpins, etc., requires quick action. Wherever it is prac-

ticable on fixed bearings use the backs of your fingers to feel with, as they are more sensitive to heat than the hardened working surfaces of a man's hand."

"Schmidt ought to use that nose of his, as they say he is very sensitive about the length of it," suggested O'Rourke, who, for him, had been silent for a long time.

Schmidt retaliated by saying that it would never do for O'Rourke to use his cheek for feeling journals, as the metal would have to be red hot for him to even notice it by that method.

McAndrew called them both down hard for making such personal references, and said that oilers were supposed to be courteous to one another. If they are not there might be all kinds of trouble when relieving one another as the watches changed. "The man about to be relieved," said he, "must have all his oil reservoirs filled up and all the bearings and journals under his care running cool, or otherwise the oiler coming on watch could refuse to relieve him.

"I hope," he continued, "that O'Rourke and Schmidt never have to relieve one another from oilers' watches, as I am afraid they would both be standing double watches the greater part of the time."

"Chief, won't you put us onto some of the duties an engineer has to do in port?" suggested Schmidt, who was probably the most eager for knowledge of any in the class.

"Certainly," replied the general instructor. "The first thing most of them do is to beat it for their own homes, or someone else's home, according to circumstances. Of course, that is natural, as a man who stands engine-room watches for a week or more at a stretch, is mighty glad to hit the beach and stretch himself out in a four-poster at least one night in ten; but, seriously speaking, there are many important things which the engineer's gang must do before sailing day arrives again. Nowadays any repairs involving machine work of any description is put into the shops, as the engineer's force usually has neither time nor the necessary tools for making any very extensive repairs. The work most usually performed in port might be divided up under four headings. Cleaning is one of the first things to perform; adjustment of bearings must be attended to; making new joints and packing of stuffing-boxes must be performed, and examinations of the interiors of cylinders and the auxiliaries must be made periodically. These four divisions of work probably constitute nine-tenths of the duties performed in port.

"As soon as the jingle-bell is rung, signifying 'through with the engine,' the boys should be set to wiping the engine down and cleaning up the floor plates. Some engineers like to have a small injector so fitted and connected up that it can be used to wash down the bed-plates and bilges with hot water; but I don't believe in squirting salt water indiscriminately about an engine room, as it is bad for the bearings and bright work. Gaskets, made of hemp, loosely laid up, should be laid across both ends of all the principal journals to keep out any dirt or grit which might be around while the engine is not in use. During the stay in port, bulkheads should be scrubbed if they have become dirty, storerooms cleaned out and put in good order, bilge strainers cleaned thoroughly, the bilges themselves cleaned and kept well painted, the filtering material renewed in the feed tank, and in a general way the whole department given such cleaning, painting and renovating as cannot well be done while the machinery is running.

"The adjustment of bearings is probably one of the most important duties for the engineer and his assistant. If a bearing runs a little slack and develops a slight pound it should be carefully readjusted, or if there has been a tendency for any particular bearing to heat up during the trip it should be examined, and if necessary overhauled and readjusted while the ship is at the dock."

"Why are they always monkeying with the crankpins on this ship?" asked O'Rourke. "It seems to me," he continued, "that that is all one of the assistants does while this ship is at the dock. I see him running around with something that looks like a handful of spaghetti, and he is always saying that he has got her down to 29, or some number like that. You'd think he was running a keno game. He ought to——"

"Well, O'Rourke," interrupted the chief, "if you're running this talkfest I'll quit and let you take the chair."

"I'm through," meekly replied the Hibernian, realizing, for once at least, that he was sat upon.

"Bearings lined with white metal are now almost universally used," said McAndrew, after re-establishing himself as boss of the school room. "These wear down considerably during long-continued runs, and consequently must be adjusted more often than the old-fashioned bearings of solid brass. In the early days it was the test of a good engineer to make adjustments by chipping and filing down the edges of the brasses uniformly, as that was the method then in vogue. All bearings in these times have pieces of brass, known as distance pieces, between the upper and lower brasses; when the wear has been excessive these distance pieces can be planed down in a shaper very quickly. However, that is seldom necessary, as liners, or shims, consisting of varying thicknesses of sheet brass, are also fitted between the distance pieces and the brasses. By removing one of the thinnest liners a very small lost motion can be taken up and the tendency of the bearing to pound prevented. Of course, it is necessary to have some slight clearance to all bearings, else it would be difficult to distribute the oil over the rubbing surfaces. A good rule to remember for the amount of the clearance is that for every inch of diameter of a bearing there should be two one-thousandths of an inch of space. Thus for a 12-inch crankpin the clearance should be $12 \times .002 = .024$ inch. This corresponds practically to No. 24 B. W. G., which is a safe clearance space. Some engineers would set them up tighter than that, but when they do there is always a good chance for them to heat. By the same rule a 6-inch diameter crosshead pin should have .012 inch clearance, which corresponds to No. 30 B. W. G."

"What's that mean, chief?" asked Pierce.

"B. W. G. means 'Birmingham Wire Gage.' Wire, you know, is made of a great many different diameters, and instead of expressing them as so many thousandths of an inch, it is much simpler to say No. 1, 7 or 27, or whatever it happens to be. Birmingham in England is one of the leading wire manufacturing communities, so the gage most generally used is the one which was adopted at that place many years ago.

"In adjusting a bearing, as, for example, the main bearings of the engine, the cap or top part should be removed by means of a chain hoist, and the white metal and oil grooves examined. If it is found that the brass does not bear well on the shaft journal it must be scraped down to a good fit. To do this properly the journal should be smeared over with a thin coating of red lead and oil and the cap put back in place. Where the white metal of the brass touches the shaft there will be red spots. These spots should all be carefully scraped down and the cap again tried as before. After this is repeated several times, the brass should be found to bear on the journal quite uniformly. Always remember that the principal bearing should be in the center of the brass. The outside edges should not touch at all, for if they bear on the journal when it is cold it will be found when the temperature of the bearing rises to a working heat there will be a tendency for the edges to squeeze in on the shaft; or nip, as it is termed, which will cause the bearing to become overheated. It is also necessary to fit them in this way to provide for wear, the heaviest of which is naturally in the center of the brass. After the bearing is found to be satisfactory, so far as its surface is concerned, the oil grooves should be carefully cleaned out, and enlarged where necessary, as it is of vital importance to have

the grooves amply large and so placed that a uniform distribution of the oil will take place.

"For final adjustments three strips of lead wire about 1/16 inch in diameter should be laid across each journal, one at each end and one in the middle. The cap should then be replaced, and the main bearing nuts set down as tightly as possible by means of a box-wrench and a sledge. The position of the nut in reference to the end of the bolt should be marked with a scriber, so that you will know how tight to set up on the nuts after the cap has again been taken off and the three pieces of lead wire removed. The leads, as they are called, should be measured by means of the wire gage, to see that they are of about the thickness necessary for the desired amount of clearance. A more accurate method for determining the amount of clearance from the leads is by means of the micrometer."

"Mike who?" interrupted O'Rourke.

"Don't let that word bother you, as the instrument is not an Irish invention, even if its first name is Mike," rejoined McAndrew. "It is more than likely it was invented by a German; but at any rate it is a very useful measuring machine, by means of which, through the medium of an accurately cut screw head and a graduated sleeve, thicknesses of one-thousandth of an inch, and even of one ten-thousandth inch can be readily measured. When you get to be engineers you will find it very useful to save these leads, or spaghetti, as O'Rourke calls them, for future reference. A convenient way to do it is to get a large brown-paper book, a scrapbook will do, and cut slits in the pages through which the leads can be held in place. Mark under each set of three leads the name of the bearing from which they were taken, the date, and opposite several points in their length jot down the thicknesses in thousandths of an inch.

"Even if a crankpin has been adjusted to your satisfaction by means of leads, it is always a wise precaution to put the end of a pinch bar in between the end of the brass and the crank-web, and if it does not move with a 'chug' after a quick yank on the other end of the bar, the brasses are probably too tight, and should be slacked up slightly until they can be moved in that manner.

"When eccentric straps become noisy, they should be taken apart and a small shim removed; but they should never be set up so tight that they cannot be moved all around by hand after the bearing surfaces have been oiled.

"Journals connected with the valve gear do not need adjusting very often, but when they do it is a comparatively simple matter, especially if they are fitted with strap, gib and key connections, as many of them are. When first constructed it is usual to leave from 1/16 inch to ⅛ inch clearance between the two brasses, so to adjust them afterwards it is only necessary to drive the taper key in a little further, always being sure to set up tightly on the set screw.

"Many small pin bearings where the wear is trifling are fitted with solid bushings of brass. When they become badly worn the bushings should be renewed.

"The making of new joints and packing small stuffing-boxes should be attended to while the vessel is in port, as there is nothing that annoys an engineer more while the vessel is underway than to have one of these blow out. It is a strange fatality, if I might call it that, that joints and stuffing-boxes always give way at the most inopportune times. A joint will run along perfectly tight while the ship is in a cold climate, but just as soon as she gets down South, and on some particularly hot day, 'bang!' out blows the gasket, and fills an already hot engine room full of steam and vapor.

"Then, too, it is generally the joint which is hardest to get at which lets go, while some joint that is easily remade will run along as tight as a bottle for months at a time. The engineer who is onto his job will have all suspicious joints remade while the vessel is tied up to the wharf and there is time to do the job properly.

"The making of joints and packing of stuffing-boxes is something you will have to learn from actual experience. The various materials from which gaskets are made are as numerous as the first man up San Juan Hill, and some of them just about as reliable. As a rule, you should use only rubber gaskets for joints in water pipes. For steam joints various fibrous materials, asbestos woven with wire and usudurian are the best and last longest. In making steam joints you must be exceedingly careful to see that all the old material is scraped from both flanges, and that the flanges themselves are parallel. The holes in the gasket should be cleanly cut, and before it is slipped in place the packing should be smeared over on both sides with black lead and tallow or cylinder oil. Set up on the bolts just as tightly as possible, but not so hard as to twist some of them off, as is done occasionally by muscular young men like O'Rourke."

"Honest Injun, chief, that wasn't me that twisted that stud off the feed pump this morning. I won't say just who it was, but I think he can speak German," protested O'Rourke.

"Oho! so one of you is guilty of that very same thing only this morning, eh? Well, whichever one of you highbrows it was will have the pleasure of putting in a new stud while you are resting yourselves off watch to-morrow.

"As I was saying," resumed McAndrew, "the bolts on a new joint should be set up as tightly as possible, and then after steam has been on the pipe for an hour or so, they should be followed up, as the saying is, as the heating of the gasket usually allows a little more tightening.

"In packing stuffing-boxes, the turns of packing should be put in so that the joints do not come opposite one another, and this packing should also be rubbed down with black lead and tallow."

"Why do you do that, chief?" asked Nelson.

"It isn't that it does any particular good in keeping the stuffing-box tight, but it makes it much easier to remove the packing when it is worn out and again has to be repacked. In marine engineering, no matter what you do in the way of construction or repairs, you must provide for all manner of things which may happen in the future. You don't want to be caught like the man who built a boat having a 6-foot beam in a cellar with only a 3-foot door to get it out of and didn't notice the difference until the boat was finished.

"Certain parts of marine machinery need to be inspected to see that everything is in good condition. I don't believe, as some engineers apparently do, in taking an engine or an auxiliary apart to see what makes it work so well, but at regular periods, say every three or four months, the cylinder heads should be lifted to see that none of the follower bolts is cracked or has become loose. Water ends of air pumps, feed pumps and bilge pumps should be examined quite frequently to see that the valves have not become too much worn and the springs are not broken and are in their proper places. This is particularly necessary if rubber valves are used. The main condenser should be watched closely to see that no leaks have developed in the tubes. This is generally indicated by the water getting too high in the gage glasses on the boilers, as salt water will leak through the tubes to the fresh water side of the condenser and mix in with the feed water, causing a surplus. If you have reason to suspect that any of the tubes are leaking the condenser should be filled with water, the water chest at each end removed, and the ends of all the tubes examined carefully to see if any water is running out. If it does, that indicates that the tube is leaking and it should be removed at once. If there are spare tubes on hand fit one of them in its place or else plug up the holes in the tube sheets.

"After several months of use, condenser tubes become covered with grease from the exhaust steam and fall off in their efficiency of transmitting the heat from the exhaust steam to the circulating water. This is generally indicated by the vacuum falling below its usual height, and the con-

denser should be boiled out with a strong solution of soda and water heated by means of a jet of steam.

"There are, of course, many other jobs to be attended to while a vessel is in port; in fact, the duties of an engineer while the vessel is tied up remind me of the tribulations of a 12-year-old playmate of mine when I was a youngster. He would get home from school about 4 o'clock in the afternoon, and upon reporting to his fond stepmother would every day be saluted about as follows: 'Now, Lewis, you hurry up and get ten or twelve baskets of chips from the shipyard; run up to the grocery store for me; hoe five rows of potatoes; chop the kindling for the morning; get six pails of water and then you can play the rest of the time before supper.'

"After performing all the numerous chores I have told you about which have to be done in port the average engineer who follows the sea can play the rest of the time; but I am afraid that it is mostly after supper that he finds the opportunity."

(*To be continued.*)

Diesel=Engined Tugs

BY J. RENDELL WILSON

During the last few years so much attention has been drawn to the advantages of the Diesel type engines for ocean-going ships that little has been done to direct the thoughts of shipowners toward the adoption of this class of power for towboats, so it is doubtful if there are more than a couple of dozen Diesel-driven tugs in service in all parts, and probably the majority of these are working in Hamburg harbor.

For many reasons this class of engine shows vast economy over gasoline (petrol) and steam machinery for this particular type of boat, chiefly because of the low grade of oil fuel that can be used, and the near future should see the substitution of heavy oil engines for the gasoline (petrol) and steam engines in the thousands of tugs in service in various parts of the States. Before this can occur however, the manufacture of these motors will have to become more general in America, and better arrangements for distribution of heavy oil fuel will have to be made by the oil companies. As soon as the demand comes, however, this should offer no difficulty, as the refiners will be enabled to distribute the oil through the medium of the present gasoline (petrol) stations. In England and on the Continent heavy oil fuel, although very expensive, is now obtainable practically anywhere, and this state of affairs should soon prevail in America.

As to the construction of the machinery, the New London Ship & Engine Company, of Groton, Conn., has already made considerable headway, and other concerns will soon be in full swing, including the American branch of Krupps, the famous German naval firm. The economies, however, are so considerable that it pays a shipowner to order an oil engine from England or the continent, despite the extra carriage and duty.

In addition to fuel consumption, the advantages over steam are: No standby charges, no stoker, less bunker and machinery space and the opportunity of carrying a moderate cargo if desired. A good example will be found in Fig. 1, which shows a tug and icebreaker designed by the A. B. Diesels Motorer, of Stockholm. The tug is 56 feet in length, 53½ feet between perpendiculars, with 14 foot molded beam, 9½ foot molded depth and a draft of 6 feet. Her engine is a four-cylinder (with two extra maneuvering cylinders) Polar-Diesel of 120 brake horsepower, which drives the boat at 9½ knots. The engine-room is placed amidships, between bulkheads, and on either side of the engine are arranged the fuel and compressed air tanks, and the total space required is just 14 feet by 14 feet, and the weight of the machinery is 9 tons. A steam engine of the same power, i. e., about 160 indicated horsepower, with boilers and condensers, would require an engine-room about 45 percent larger and the machinery would weigh 90 percent more. With a fuel supply of 6 tons the Diesel tug could run for 230 hours, as against the 45 hours of the steam tug with the quantity of coal, which, by the way, would require more space. As the average costs per ton of the two fuels, I believe, are about the same in the States, the economy is at once apparent, as in one case we have a cruise of 2,185 nautical miles with 6 tons of fuel, and in the other but 427½ nautical miles with the same amount of fuel. This boat has excellent accommodations, which consist of a wheel house, galley and lavatory on deck and captain's cabin, cabin peak, messroom, pantry, engineer's cabin, crew's cabin, storeroom and water ballast tank below deck.

Let us now turn to the question of gasoline (petrol) versus heavy oil. The latter type of engine is heavier and generally runs at slower revolutions, but owing to the greater power-giving efficiency and propeller efficiency the actual space required for the two installations will be about the same; but the Diesel will cost about 15 to 20 percent higher, and if imported from abroad another 45 percent will have to be added to the first cost.

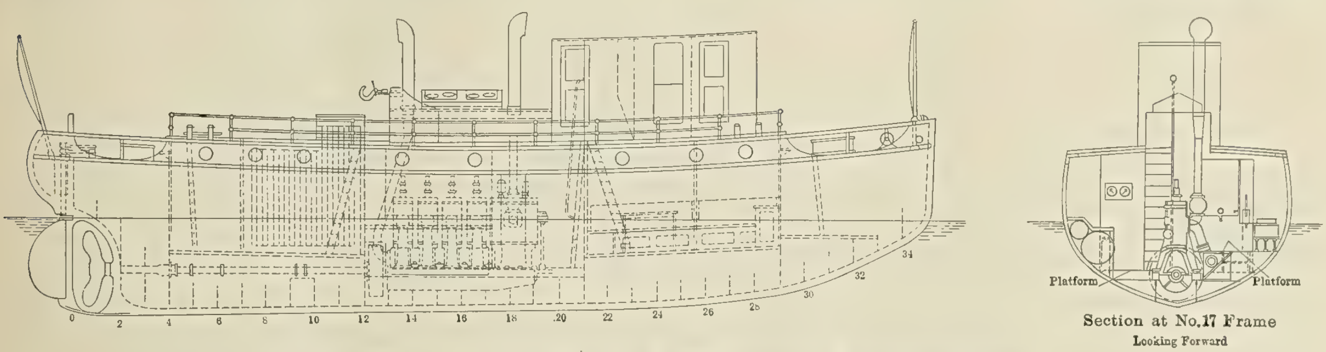

Fig. 1.—Tug and Icebreaker Fitted with 120-Horsepower Polar Diesel Engine

For the purpose of comparison we will take a gasoline (petrol) motor of 150 brake horsepower and a Diesel of similar power, the former having a fuel consumption of .75 pint per brake horsepower hour, and the latter .5 pint per brake horsepower hour. In actual practice the consumption would be more likely to be .80 and .45 pint, respectively, so we are quoting in favor of the gasoline (petrol) motor. The cost of the fuels per gallon will be about 20 cents (0/10), and 5 cents (0/2½), respectively, so the gasoline (petrol) motor has a consumption of 132½ pints, or say, roughly, 16 gallons per hour, while the Diesel engine consumes 67.5 pints, or about 8½ gallons per hour.

Thus for a voyage of 12 hours at full speed the gasoline (petrol) tug will require 192 gallons at 20 cents (0/10), or a fuel bill of $38.40 (8/0/0), as against 102 gallons at 5 cents (0/2½), or a fuel bill of $5.10 (1/1/3). Working for 330 days of the year this means that the cost of fuel for the gaso-

line (petrol) tug is $12,672 (£2,600), while the Diesel towboat total fuel cost is $1,775 (£364). This shows a saving of $10,897 (£2,236) per annum, out of which we should allow the odd $897 (£183) for the renewal of exhaust valves, etc, which is fairly frequent with some types of Diesel engines. However, it is obvious that $10,000 (£2,062) saved yearly is well worth the extra first cost of this class of engine, and in some cases of even the actual scrapping of existing machinery. The original cost of a 200 brake horsepower Polar-Diesel marine motor of the best finish is about $12,200 (£2,500), with accessory fittings, such as compressors, tanks, etc., or some $1,220 (£250) less for the bare engine.

Several of the existing Diesel tugs are of much higher horsepower than this, while Messrs. Benz & Company, of Mannheim, Germany, are now building one of 500 brake horsepower, and there is no reason why 1,000 horsepower motor tugs should not be built if required, as there are no engineering difficulties now in the way. The Nobel Bros. Naphtha Company, of St. Petersburg, have had a large twin-screw motor tug, the *Jakut,* running for several years, and Fig. 2 illustrates this boat. She is driven by two 160 brake horsepower Polar-Diesel engines, which turn at 240 revolutions per minute, and was placed in service in 1910. Some time ago she and a sister steam towboat put out from Astrakan to render assistance to a steamship that was fast in the ice. From the time of leaving harbor to the time of the return the consumption of oil was 267 pud, compared with the consumption of coal, which was 1,974 pud.

Fig. 2.—Diesel-Driven Twin-Screw Tug *Jakut*

In a recent issue of a London motor boat paper is given details of the wonderful economies effected by an oil-engined combined tug and cargo boat owned by Crosse & Blackwell, and now working on the Thames. Before the advent of this craft the owners paid about $200 (£41) per week for towing by steam towboats, whereas the running costs and upkeep, which includes wages, insurance, overhaul, depreciation and interest on the first cost of their new motor boat, only amounts

Fig. 3.—Sulzer-Diesel Engined Tug in Hamburg Harbor

to $62 (12/18/4) per week, so that there is a direct saving of $138 (£28) per week, apart from the additional gain effected by carrying 50 tons of cargo on board the tug. So that the total saving easily exceeds $7,000 (£1,435) per annum. The tug is but 63 feet long by 13½ foot beam, with 6 foot extreme draft. She is equipped with a single-cylinder Kromhout heavy oil engine of 45 brake horsepower, which uses gasolene* fuel costing 9 cents (0/4½) per gallon. The consumption is under 4 gallons per hour, so the running cost for fuel alone is about 36 cents (1/6) per hour at full speed. The engine-room occupies a space but 14 feet by 13 feet, allowing 38 feet for her length being given over to cargo. The remainder of the space forms the crew's accommodation. Her speed is 7¼ knots.

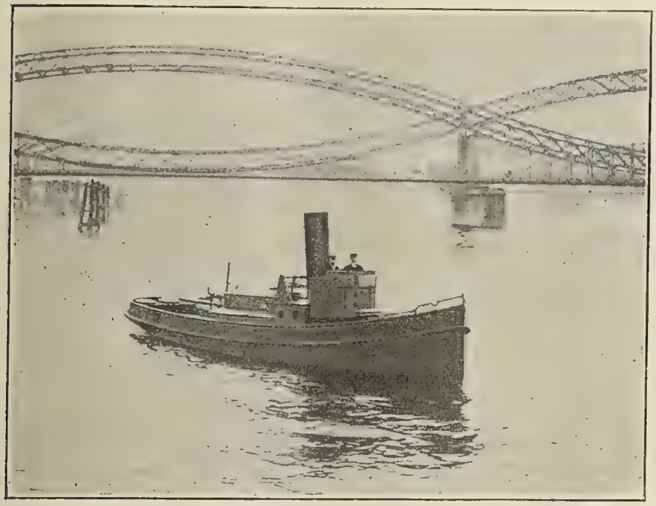

Fig. 4.—Tug Fitted with 80 Horsepower Benz-Diesel Engine

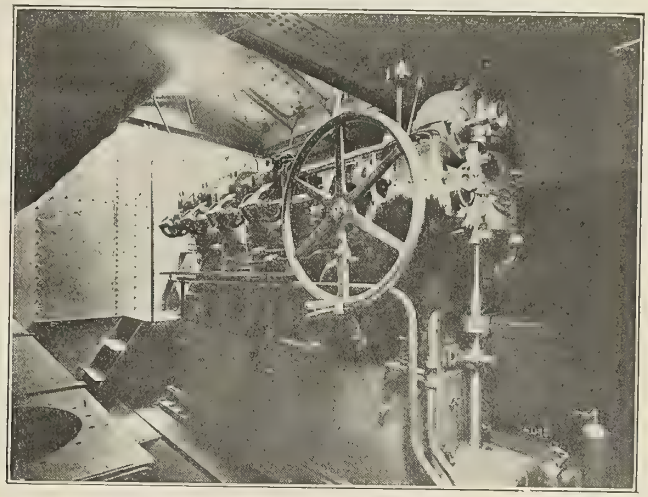

Fig 6.—Engine Room of 100 Horsepower Sulzer-Diesel-Engined Tug

Fig. 5.—A Tug Fitted with a 300 Horsepower M. A. N. Diesel Motor

The first marine Deisel installation carried out by Messrs. Benz, of Mannheim, was the conversion of a 60 indicated horsepower steam tug in 1911, and in the same machinery space there was found enough room to install a Benz-Hesselman motor of 270 indicated horsepower, giving her an average speed of 10 knots. She is owned by Messrs. Strass & Söhne, of Braila, and is used by them on the Donau River. This little craft is built of Siemens-Martin steel and the hull is divided by four bulkheads. *Benz,* as she is named, is 55½ feet long by 13 feet beam, with 7 foot depth, and was built by J. W. Klawither, of Dantzig. Her accommodation includes captain's cabin, deckhouse, galley, engine-room, engineer's and pilot's cabin and the crew's compartment.

These owners have now quite a small fleet of Diesel-driven tugs, including the *Benz,* three others with 270 indicated horsepower motors, and the *Schonlind,* a boat with Benz-Hasselman engines of 345 indicated horsepower at 240 revolutions per minute. These boats haul cargos up to 1,000 tons deadweight between Turn-Severin and Braila on the Donau River. The *Schonlind* is 84 feet in length by 16 feet 3 inches beam, with 9-foot molded depth and nearly 6-foot draft.

Some important experiments with tar oil as fuel were carried out recently on the new motor tug *Benz* 16, which is in service on the Rhein. This boat is just over 68 feet long by 15-foot beam and is fitted with a two-stroke Benz-Hesselman-Diesel engine of 270 indicated horsepower. In view of the efficiency of the spraying injection valve usually fitted with these motors no alterations were necessary. It was found that with this fuel—tar oil of 8,900 W. E. heating value—the cost was one-fourth that of steam machinery of similar power, and that five times the cruising range was possible for the same quantity of fuel. The average fuel consumption was 175 grammes per indicated horsepower hour.

On the River Rhine there is a large motor tug in service. This is the *Nürnburg,* an 81-foot 4-inch by 15-foot 7-inch boat, built by J. & A. Schuzt, of Rotterdam, and engined by the

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* Author's Note—A totally different fuel from gasoline (petrol).

Maschinenfabrik Augsburg, Nürnburg. She is fitted with a six-cylinder reversible two-stroke M. A. N. Diesel engine of 300 brake horsepower and has a speed of 9.1 knots. The pistons are of the stepped type, the larger or lower section forming the scavenging pumps. This is the type of motor that the New London Ship and Engine Company, of Groton, are building under license, and was fully described in this journal some time ago. The tug *Nürnberg* can tow 1,140 tons upstream and 2,400 tons down stream.

In Hamburg harbor two of the many oil-engined tugs in service are equipped with Sulzer-Diesel motors and Fig. 3 depicts one of these small vessels which is doing good service. The other is the *Fortschritt*, a boat 52½ feet long by 15-foot beam and 5-foot 11-inch draft. She is fitted with a four-cylinder two-stroke Sulzer-Diesel motor of 210 brake horsepower, which gives her a speed of 9¾ knots. This engine can reverse as quickly as a steam engine, and, compared with a sister tug driven by steam, there is a saving of engine-room space of one-third, while the weight is one-fourth. In weight 25 percent less fuel is carried, yet she can carry enough oil for eight days' service.

Appointment of New Chief Ship Surveyor to Lloyd's Register of Shipping

The General Committee of Lloyd's Register of Shipping has appointed Prof. Wescott S. Abell, professor of naval architecture at Liverpool University, to succeed the late Dr. S. J. P. Thearle in the office of chief ship surveyor to the society. Mr. Charles Buchanan, who was Dr. Thearle's senior assistant, has at the same time been promoted to the position of principal of the chief ship surveyor's staff.

These appointments are of great importance to the shipping community, not only of the United Kingdom, but also of other maritime countries. At the present moment the tonnage classed by Lloyd's exceeds 22,500,000, 40 percent of which is owned outside the United Kingdom, while the tonnage in course of construction with a view to classification exceeds 2,000,000 tons.

Professor Abell was born in 1877. His professional education commenced in the Royal Naval Engineering College, Devonport, and was continued at the Royal Naval College, Greenwich. In 1900, he was appointed to the Royal Corps of Naval Constructors; from 1904 to 1907 he was professional secretary to the director of naval construction, and for the next three years (following in the steps of the late Sir William H. White and Sir William E. Smith) he held the position of instructor in naval architecture at the Royal Naval College. In 1910 he was selected to fill the chair of naval architecture at Liverpool University.

The professional reputation which he won for himself at a comparatively early age is illustrated by the fact that he was appointed last year by the Board of Trade to be a member of the Load Line Committee, which is now sitting to consider the existing Freeboard Tables, and was selected as chairman of a sub-committee to prepare draft rules for submission to the International Conference to be held later on. Professor Abell's duties in this capacity have involved the investigation of the relation of strength of structure to freeboard and also an exhaustive comparison of the varying rules and practice of the several classification societies.

Among the technical papers which have been read by Professor Abell may be mentioned one on the General Action of Capsizing Forces, before the Liverpool Engineering Society, and one on Methods of Calculation for Investigating the Safety of Ships in Damaged Condition, before the Institution of Naval Architects.

Mr. Charles Buchanan, for whom the office of principal of the chief ship surveyor's staff has been created, has been associated with mercantile shipbuilding throughout his professional career. Prior to joining the service of Lloyd's Register in 1880 he held the position of chief draughtsman with Messrs. A. McMillan & Sons. Later he enjoyed a varied experience in professional work at various shipbuilding ports in the country. Since 1891 he has been stationed in London, holding for the last seven years the position of assistant to the chief ship surveyor. For many years past he has been associated particularly with the duty of dealing with plans of vessels submitted for the committee's approval, and this work has given him exceptional knowledge of all the latest developments of shipbuilding practice throughout the world. Mr. Buchanan has lately been appointed by the Board of Trade to be a member of the Departmental Committee on Bulkheads and Watertight Compartments in Ships.

Gasoline (Petrol) Cruiser for Peru

The Gas Engine and Power Company and Charles L. Seabury & Company, Consolidated, Morris Heights, New York City, have under construction from their own designs a 42-foot raised-deck gasoline (petrol) cruiser for the use of the President of the Republic of Peru. This is the third boat to be built from this design, the other two, the *Vagabond* and the *Spray*, being owned by prominent yachtsmen of this country. The dimensions are: Length overall, 42 feet; beam, 9 feet 6 inches; draft, 3 feet. A four-cylinder four-cycle six-inch by six-inch Speedway 38-48 horsepower motor is installed, which

Motor Boat for Peruvian President

gives the boat a speed of 12 miles per hour. There is a large self-bailing cockpit aft, forward of which is the engine-room, together with the galley and engineer's berth. The cabin itself is 14 feet long, fitted with four extension transom berths. Forward of the cabin is a toilet room. The boat will be lighted by an Apelco electric lighting system.

Shipbuilding and Marine Engineering in the United Kingdom in 1913.—According to returns sent to *Engineering* by 124 shipbuilding firms and 93 marine engineering firms in the United Kingdom, 1,204 vessels of a total tonnage of 2,237,000 tons were launched during 1913. The collective power of the propelling machinery built was 2,679,000 horsepower. Including the work done in the Royal Dockyards in 1913, the total tonnage launched during the year aggregates 2,311,960 tons, which is 203,730 tons, or 9.65 percent, more than in 1912, and 223,302 tons, or 10.7 percent more than in 1911. The total horsepower for 1913 given above is 408,000 horsepower, or 18 percent more than that built in 1912, and 437,500 horsepower, or 19.5 percent more than was built in 1911. In practically all of the shipbuilding districts, with the exception of Wear and Ireland, there was a very substantial increase in the tonnage launched in 1913 over that of 1912. On the Clyde the increase amounted to 19.2 percent; on the Tyne, 13.1 percent; on the Tees, 12 percent, and at Hartlepool, 31 percent.

The Twin-Screw Steamship Köningin Luise

Turbine-Driven Vessel Fitted with Föttinger Hydraulic Reduction Gear—Results from Carefully Conducted Trials

BY F. C. COLEMAN

The twin-screw steamship *Köningin Luise,* built at the Vulcan Works, Hamburg, for the passenger service of the Hamburg Amerika Line has the following leading dimensions:

Length between perpendiculars	275 feet
Breadth, molded	38.62 feet
Depth to promenade deck	23.45 feet
Draft, loaded	9.75 feet
Displacement	1,800 tons

The interesting feature of the equipment of the vessel is the adoption of the Föttinger transformers between the turbines and the propellers, which not only has effected a reduction in speed between them in the ratio of 4.03 to 1, but, when required, reverses the relative direction of rotation, so that while the turbines run continuously ahead, the screw may run either ahead or astern.

Hamburg-American Liner *Köningin Luise*, Fitted with Föttinger Transformers

Boilers

She has three boilers of the Yarrow watertube type, fitted with uptake superheaters and Howden's hot-air forced draft. The amount of superheat is, however, small, being about 60 degrees Fahrenheit. The superheating surface is 300 square feet and the working pressure 240 pounds per square inch.

The total heating surface is	12,220 square feet
The total grate surface is	258.1 " "
H.S./S.H.P.	2.44 " "
S.H.P./G.S.	19.3 " "

There are two independent turbine sets, each designed to give 3,000 brake horsepower at 1,800 revolutions per minute. They are fitted, one on the port and the other on the starboard side of the ship. These turbines are in hydraulic connection with the port and starboard propeller shafting through the Föttinger transformers.

The principal advantage of this system of transmission is that the astern turbine is dispensed with, and consequently there is a considerable reduction in the losses due to an astern turbine, and there is a saving of weight and space. Further, the main turbine can be run at a speed which is practically constant, and in one direction only, so that during maneuvering there is no sudden change of temperature in the steam. In a reversing turbine, which must usually be not much hotter than the condenser, the inflow of boiler steam has a tendency to cause damage. Steam with a considerable amount of superheat can be used without fear of damage to the turbines when the Föttinger transformer is used. Also great rapidity of reversing is obtained by this system and freedom from noise.

Turbines

The turbines in the *Köningin Luise* are of the combined impulse and reaction type, the impulse part being aft of the reaction. Steam nozzles arranged in three groups of twelve each are fitted. Under normal working conditions two groups only are in use, but for extra power a third group controlled by a separate stop valve can be used. The nozzles are arranged circumferentially on the aft end of the casing at a radius from the center line of the shaft of about 2 feet 6 inches. In the impulse part of the turbine there is one Curtis wheel, having two rows of buckets. There are seven expansion stages in the reaction part. The exhaust is led to the condenser from the low pressure end of the turbine through a large exhaust bend.

On the forward end of the turbine shaft a centrifugal governor is mounted which operates a small piston valve in a valve chest, connected by means of a system of piping to a balanced piston valve, which works the main throttle valve for regulating the admission of steam to the main turbine nozzles; the pressure for working this system is obtained from the main feed line. The object of this governor is to control the speed of the main turbine automatically when maneuvering. The throttle can also be worked from the starting platform by means of a hand wheel and rod. The governor also operates the steam throttle valve on the water pressure or makeup pump for the transformer. The speed of the latter pump can also be controlled from the starting platform.

Reduction Gear

Keyed on to the after end of the primary or turbine shaft is the primary water wheel. Keyed on to the propeller shaft are two secondary stage wheels, which are bolted together. The water from the primary wheel delivers up part of its energy to the vanes in the first secondary stage wheel. From here the water is led through stationary guide blades fixed in the casing to the secondary stage wheel, where it delivers up the remainder of its energy, and it is then returned to the suction side of the primary water wheel, where it receives energy by acceleration from the primary shaft, and the operations above described are repeated. Some leakage takes place during the passage of the water at a high pressure. This leakage is made up as is described later.

The primary water wheel is contained in a separate chamber forward of the ahead section, and is keyed on the turbine shaft. This wheel discharges through blades which are fixed in the casing and are set so as to reverse the direction of the flow into the secondary wheel. This wheel is bolted to the first secondary stage wheel of the ahead section and through this is connected to the propeller shaft, which it drives in an astern direction. Owing to less power being required for going astern, sufficient energy can be extracted from the water in one stage, so that there is only one secondary stage wheel in the astern section of the transformer instead of two, as in the ahead. The astern power is about 70 percent of the ahead power.

Governor

It will be seen from the above that when maneuvering the main turbine can be kept running at a constant speed in one direction. This speed is controlled by means of the governor. The makeup pump is of the centrifugal type, having its shaft vertical, and is driven by a small independent impulse steam turbine. The pump chamber is submerged in the tank which supplies the water to the transformer. The pump discharges through the main maneuvering valve into either the ahead or astern portion of the transformer.

Boiler feed water is used for the transformer, and is being constantly heated owing to the work done upon it in the transformer. In order to save this heat and put it back into the boiler, part of the water from the air pump discharge is admitted, through a regulating valve to the transformer tank, and an equal amount is drawn off (by means of a branch in the discharge pipe which leads from the makeup pump to the transformer), and is led to the main feed pump section tank. There is an indicator above the engine-room floor, which shows the water level in the transformer tank, so that it may be seen that the amount of water sent back to the boiler from the transformer is equal to the amount put into the tank. The pressure of the discharge from the makeup pump is about 57 pounds per square inch, and the temperature is usually regulated to about 170 degrees Fahrenheit. In addition to the gain due to saving this amount of heat for the boiler, it is also found that there is a considerable gain in the efficiency of the drive by using water at this high temperature, owing to the viscosity of the water being less than at lower temperatures.

The function of the makeup pump is to replace the water which leaks from the stages of the transformer. The discharge from the makeup pump is led to the transformer through the main maneuvering valves. These valves are placed horizontally, and are of the balanced piston type, worked by a hand lever from the starting platform. The ports in the valve chest are so arranged that when the primary ahead pump chamber is open to receive water the primary astern chamber is open to the drain tank and vice versa. The ports in the valve chest and the ports in the valve are so arranged that both the ahead and astern chambers can be emptied simultaneously (which is what occurs when the maneuvering valve is in its mid-position and the secondary shaft is stopped), but it is impossible to fill both at the same time. The ratio of reduction, i. e., the ratio of the turbine revolutions to the propeller revolutions at which the set is designed to run in this ship is 4 to 1. This ratio can be temporarily increased for maneuvering purposes by slowing down the makeup pump, which causes the water wheel to cavitate. The makeup pressure is regulated according to the desired number of secondary revolutions.

A thrust block is fitted aft of the transformer, which takes up any difference of thrust there may be between the propeller shaft and the secondary stage water wheels in the transformer. There is also a thrust bearing fitted on the forward end of the turbine shaft, to take up the difference between the steam thrust in the turbine and the water thrust in the primary water wheel of the transformer.

Official Trials

During the official trials, carried out between Cuxhaven and Heligoland, the contract speed of 20 knots was obtained with a shaft horsepower of 5,330 on 453 revolutions of the propeller. The vessel left Hamburg at 9.45 A. M. for her trial. At 1:20:44 the telegraph was put full speed ahead. At 1:22 the ship was absolutely stopped; time taken, 1 minute 16 seconds; distance run, not more than two lengths. The revolutions before the telegraph was rung down were 430 starboard and 435 port, corresponding to about 19 knots. The time to reverse the shaft was 8 seconds, and in another, 16 seconds; the propeller was running astern at 320 revolutions starboard and 310 port. These times were taken from the ringing of the telegraph to the moment when the propeller shaft stopped or reached its maximum revolutions astern.

This experiment was repeated at 1:31, the time taken to stop the ship being 1 minute 10 seconds. The revolutions in this case were 430 starboard and 420 port, and the vessel stopped in about the same distance, namely, a little under two lengths. In this case the time to reverse the shaft was 4 seconds. It took 20 seconds more to bring the revolutions to 320 starboard and 310 port.

At 1:44:16 a third experiment was tried. The engines were running about 430 starboard and 410 port. The propellers were stopped in 3 seconds, and were not moved for some considerable number of seconds, when they were put to full speed astern, and in 4 seconds from the time the valve was opened they were running at 370 revolutions. In this case it took 1 minute 17 seconds to stop the ship, but the stopping was done in about a length and a half. It seems as if the immediate reversing of the engines on the stopping of the propellers is not so good as allowing them to go for some seconds without being reversed. The vessel then proceeded to sea and reached Heligoland at 4:55 P. M.

On the way out, between Lightships Nos. 3 to 1, the mean speed over the ground was 20.15 knots. On the return journey the speed over the same distance was 17.5 knots. The average revolutions maintained throughout the whole of the run were port, 420; starboard, 416. The mean speed between the lightships was 18.82 knots, and the revolutions 418 port and 413 starboard. On the way back the revolutions were 423 port and 417 starboard. During part of the run, from 5.0 to 5.15 P. M., the revolutions were 430 port and 425 starboard.

Horsepower, Water and Coal Consumption

The mean horsepower, corresponding to the revolutions between the lightships out and home, was 4,480. On the high-speed run, which was not done between these lightships, the shaft horsepower was 4,810, and the revolutions 427½. The speed for this quarter of an hour was not measured, but was estimated to be 19.26 knots.

The water in which the vessel was running was shallow, so that the speed obtained is not a fair measure of the deep-water speed. But as the trial was made to test the economical and maneuvering qualities of the vessel, extreme accuracy in speed is of minor importance.

In these trials the water consumption per shaft horsepower was 12.46 pounds for turbines and gear only, as compared with 12 pounds at full load. Coal was measured on the trial and found to be 1.38 pounds per shaft horsepower (including auxiliaries), as compared with 1.31 pounds at full load. The coal (Westphalian steam) was sampled and tested at the University of Glasgow, and the ascertained calorific value = 12,220 British thermal units, as compared with 13,500 British thermal units on previous trials; thus the coal was of inferior quality.

At 5 P. M. the power was increased for 15 minutes; the average pressure at the nozzles was 181 pounds per square inch, and the mean shaft horsepower was 4,810 at 427½ mean revolutions per minute.

The pressure in the fan cases was about 3½ inches water, in the ashpits 1⅞ inch and in the furnaces ¾ inch. The following auxiliary machinery was working: Three fan engines, 1 dynamo, 2 air, feed and circulating pumps, sanitary pumps and two makeup pumps.

The machinery worked very satisfactorily throughout the three hours, and there was practically no noise or vibration from the transformer when going ahead. Also the results of the maneuvering trials show that this form of transmission is very efficient for quick maneuvering.

At the conclusion of the three hours' trial the ship was stopped in order to see whether the zero position of the torsion meter indicator had moved from that observed before starting. It was found to have slightly altered, and the mean of the two readings was taken as the true zero, from which the shaft horsepowers have been determined. The ship then proceeded up the river and arrived at the Vulcan wharf at 11:35 P. M.

The measurement of the shaft horsepower was taken by means of the Föttinger torsion meter, which measures the angular twist over a certain length of the shaft. The instrument and shaft were carefully calibrated in the shop after the trial, and the assumed constant multiplier for the twisting moment, and also the magnification ratio of the instrument were found to be correct.

The steam consumption was measured by recording the steam pressures in the nozzle used. It is known that the amount of steam which passes a nozzle depends on the size and shape of the nozzle and the pressure and temperature of the steam. This amount can be estimated; but, to have no doubt, the main turbine nozzles were taken from the ship after the trials, and the steam consumption was obtained by calibration of the nozzles. The nozzles were fitted to the exhaust receiver of the condenser in the test house and connected up to the power house boilers. The steam pressure and temperature were measured by the steam gages and thermometer as were used on the trial. The condensed steam was pumped by the airpump out of the condenser and discharged into a measuring tank. Each group of nozzles was tested at three different pressures, each for one-half hour. The results obtained confirmed the results of previous trials witnessed by the Hamburg Baupolizeibehörde.

Transformer Efficiency

The actual losses in the transformer may be classified as follows: 1. Energy dissipated in fluid friction. 2. Heat lost by radiation. 3. Heat lost by conduction. 4. Friction of bearings, thrust, etc. Of these, the first is by far the greatest. A very complete series of tests was carried out by the Vulcan Company on the starboard set before it was fitted in the ship. The secondary horsepower was measured by means of a waterbrake and the friction and other losses in the transformer were obtained by measuring the amount and rise in temperature of the leakage water from the transformer. The mechanical equivalent of this amount of heat, plus the friction in the bearings, added to the secondary shaft horsepower, gives the primary horsepower. Every precaution was taken to make the temperature and water calibrations as reliable as possible. It was found that the efficiency of the transformer varied with the temperature of the water in the transformer. This is due to the viscosity of the water. The fluid friction diminished at the higher temperature. With the transformer temperature, i. e., the working temperature at 170 degrees Fahrenheit, and at 1,070 shaft horsepower (40 percent of full load), the efficiency, including thrust block, equals 88 percent, from which it may be safely stated that, at 2,700 shaft horsepower, the efficiency would be 89 percent.

The Isherwood System of Ship Construction.—The Isherwood system still continues to make rapid progress, and the number of vessels contracted for on this system to date now totals 276, representing almost a million and a quarter gross register tons. The number of vessels built in 1913 shows a considerable advance on 1912, as will be seen from the following figures:

Year	Number of Ships	Tons
1908	2	7,329
1909	8	21,934
1910	25	92,709
1911	40	154,634
1912	52	234,615
1913	79	384,372
	206	895,593

Included in this number are vessels of all types and descriptions, and, apart from ordinary ocean-going vessels, it is perhaps of special interest to note that three other large ore-carrying vessels have been completed for service on the Great Lakes. In the development of the oil tanker the system has played a prominent part, no fewer than thirty-nine of this class of vessel having been launched in 1913. The *San Fraterno*, the 15,000-ton deadweight tanker, built on the Isherwood system, probably created more interest than any other vessel built in the current year, and is the first of twelve similar steamers building on this system, four of which have now been launched. At the present moment about 85 percent of the total oil-tank tonnage building throughout the world is on the Isherwood system, and, up to date, 103 vessels of this type are already built, or are being built on this system in the following countries:

Country	Number of Ships	Tons
United Kingdom	66	382,420
Germany	12	71,408
United States	16	51,672
France	1	3,500
Italy	7	14,000
Sweden	1	5,000
	103	528,000

Vessels have been constructed to the highest classification of Lloyd's Register, British Corporation, Bureau Veritas, Germanischer Lloyd, Norske Veritas and American Bureau, and the system has been adopted by the Governments of Great Britain, the United States and Italy.

The Second Fionia, a Twin-Screw Motor Ship

Ninth Large Motor Ship Built by Burmeister & Wain—Main Engines of the Six-Cylinder Type of Improved Construction Aggregating 4000 Horsepower

The twin-screw motor ship *Fionia,* built for the East Asiatic Company, Copenhagen, by Burmeister & Wain, of Copenhagen, was given an official trial trip in the Copenhagen Sound Dec. 18. This ship has been built to replace another vessel of the same name, which was sold by the East Asiatic Company to the Hamburg-American Line and is now operated by them under the name *Christian X.* The new *Fionia,* however, is a considerably larger vessel and is fitted with more powerful engines.

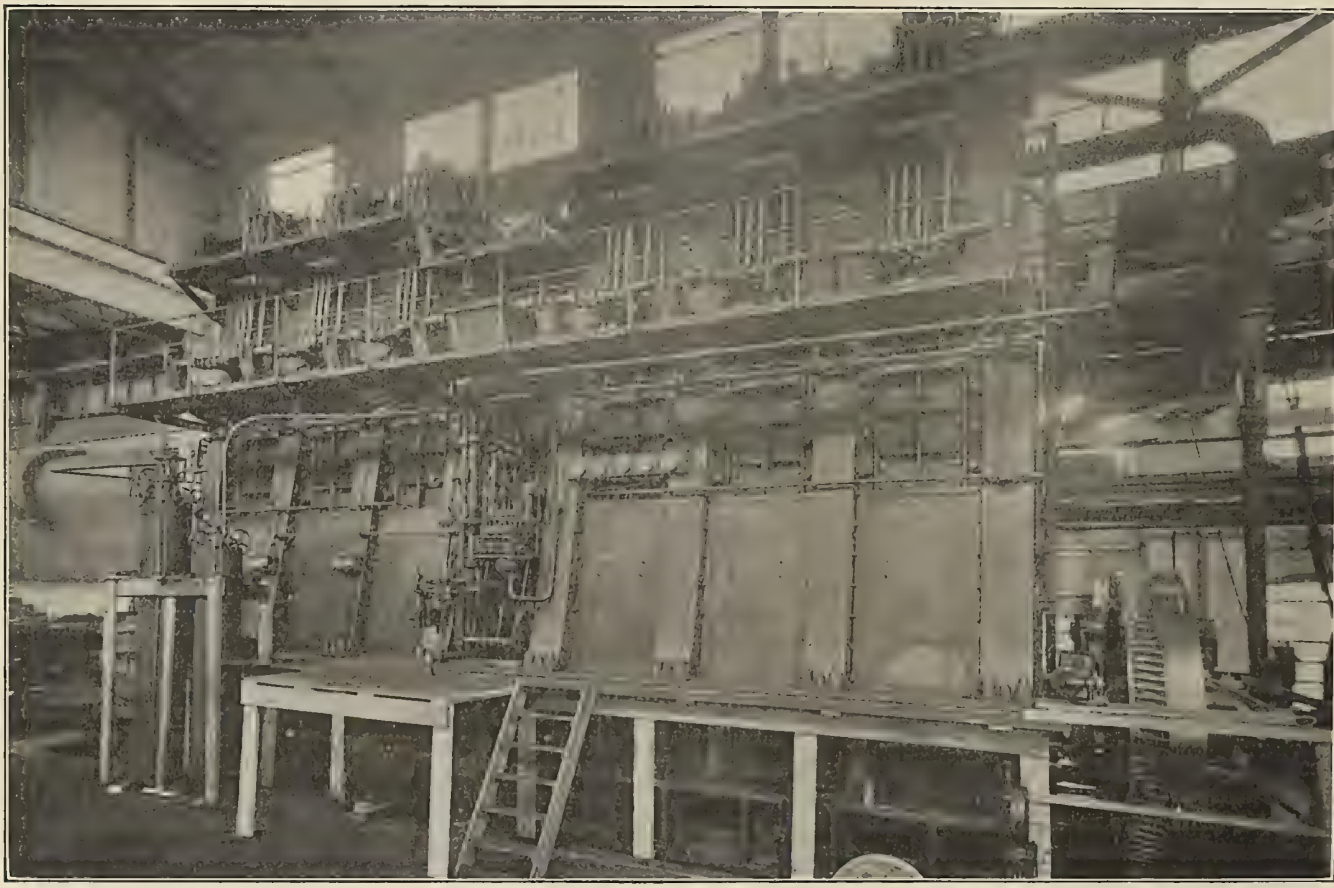


Fig. 1.—One of the *Fionia's* Main Engines

The principal dimensions of the ship are as follows:

Length over all	410 feet
Length between perpendiculars	395 feet
Breadth	53 feet
Depth	38 feet
Deadweight capacity, including fuel oil, about	7,000 tons

The *Fionia* was built for service on the Bangkok route and has accommodations for a small number of passengers. The living rooms and staterooms are splendidly furnished. The deck erection amidships, in which the accommodations are located, is fitted with large sash windows of bronze to provide adequate ventilation in the tropics. The entrance to the main saloon is through a handsome hall finished in birch wood, over which is a dome. The staircase forms a handsome entrance to the dining saloon below. Besides the dining saloon there is a ladies' saloon and music room decorated in white and gold. Above the saloons are special staterooms, each arranged with a dressing room and bath. Aft of this is a smoking room finished in mahogany, and below the smoking room are separate staterooms, each fitted with its own bath. Astern is a hospital, the barber's room and quarters for the servants and second class passengers.

The deck machinery includes twelve electric winches for loading and unloading the vessel, each capable of handling from three to five tons, and an electrically-driven anchor, windlass and steering gear. A wireless equipment is provided and a large refrigerating plant is installed for cooling purposes and for the manufacture of ice.

Main Engines

The propelling machinery consists of two four-stroke Diesel engines, each having six cylinders, with a diameter of 29.6 inches and a stroke of 44 inches. At 100 revolutions per minute these engines normally develop 2,000 indicated horsepower each.

The construction of these engines differs considerably from the construction of the eight-cylinder motors which Burmeister & Wain formerly made. As will be seen from Fig. 4, the bedplate is of the same type as is used in an ordinary steam engine. It is cast with an open crank pit and throughout the whole length below the bedplate is bolted a tray-shaped

Fig. 2.—The *Fionia*, the Ninth Large Motor Ship Built by Burmeister & Wain

reservoir of welded plates in which the oil is collected. In place of the inclosed casing on which the cylinders were supported in the former motors of this type, the cylinders are supported on separate A-shaped columns arranged so that there is an A-support at each main bearing. These A-columns are stiffly braced, the columns are connected by intermediate pieces and on the top are covers through which the piston rods pass through a very simple stuffing box. The front of the engine is, therefore, quite open, as well as the back of the engine, which is below the crosshead guides. The engine is, therefore, more accessible than an ordinary steam engine. These openings are all covered by easily removable oiltight doors of steel plates. All of the moving parts are thereby entirely enclosed in an oiltight case and are lubricated by forced lubrication.

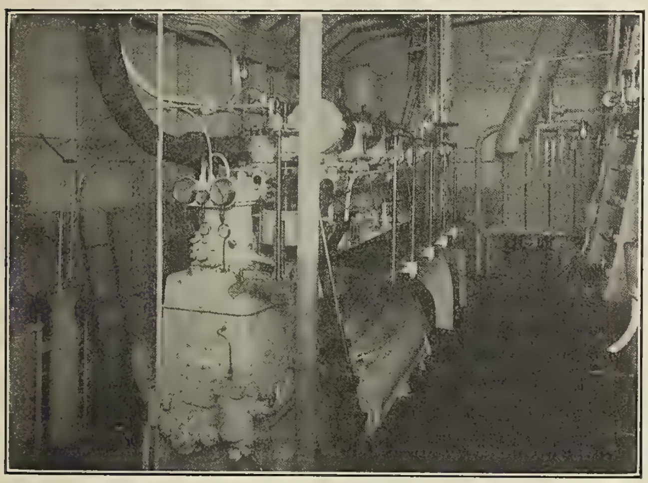


Fig. 3.—Auxiliary Motor

CYLINDERS

The cylinders are cast in two groups, each group comprising three cylinders. The cylinders are secured to the supports by lugs and the cylinders are, therefore, accessible from below, which is a considerable improvement over the previous motors, as this arrangement has the advantage that the cylinder oil dropping down from the cylinders cannot be mixed with the oil used for forced lubrication of the moving parts. The cylinder oil is collected in the tray on the top of the supports and is carried to filters through pipes. Nearly 60 percent of the cylinder oil can be collected and used again after it is filtered.

Heavy stay rods are carried from the tops of the cylinder walls through the cylinder supports to the under side of the bedplate, so that all parts of the cylinder are relieved of tension stresses.

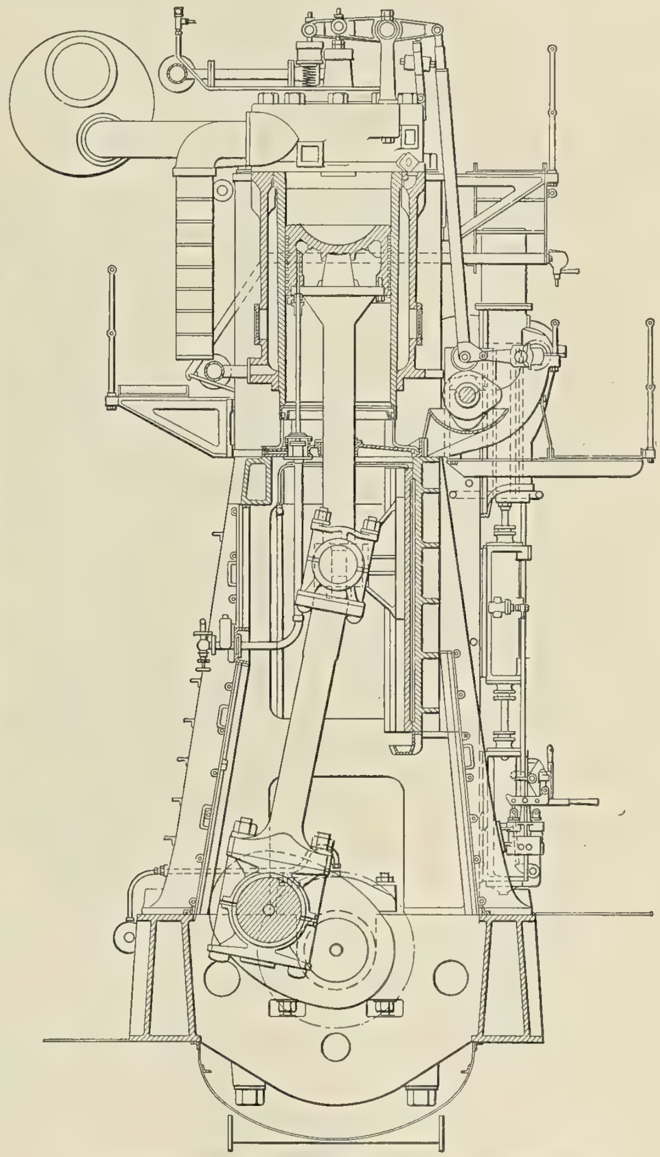


Fig. 4.—Section Through Cylinder of Main Engine

The crank shaft is built up and is bored out as formerly for the admission of oil for forced lubrication. The connecting rods, crossheads and piston rods are all made in accordance with the ordinary marine practice of Burmeister & Wain.

The pistons are cooled by sea water carried to and from the pistons by telescopic pipes, fitted with metallic packing. This alteration of cooling the pistons by water instead of by oil was not undertaken by the builders on account of difficulties

with oil-cooled pistons, but the change has been made because it would have been difficult to cool such large quantities of oil as would be necessary for cooling the large pistons.

VALVE GEAR

The valve motion is the same as used in the former motors built by Burmeister & Wain, the only alteration being that reversing is not carried out by a rotating air motor, but by a reversing engine of a type similar to Brown's gear. This is worked by the maneuvering air and its operation is both reliable and noiseless. The cam shaft is not driven by connecting rods, as in previous motors, but instead of these two spur gears are used, a design which can be made more accurate from a constructive point of view than the former.

The fuel pumps are driven by levers from one of the intermediate shafts of the cam shaft gear, and one fuel pump is supplied for each cylinder.

COMPRESSORS

The compressors for the injection of air are driven from the end of the main shaft and were built by Reavell & Company, Ipswich. In the matter of air compressors this installation differs from that in the motor ships formerly built by Burmeister & Wain, as in the former ships compressors for 20 atmospheres pressure were driven from auxiliary motors, while the main engines were supplied with the single high-pressure compressor, in which the air was compressed from 20 to 60 atmospheres. If this arrangement had been applied to the *Fionia*, with its motors aggregating 4,000 horsepower, it would have been necessary to increase the auxiliary motors to 300 horsepower, and such a motor would have been too large for working the electrical winches. When dealing with such high-powered units the builders considered it advisable to arrange the compressors on the main engines themselves.

The main engines are started by air compressed to 25 atmospheres, which is stored in two large reservoirs, each of 800 cubic feet capacity. This air is taken from the compressors on the main engines, but during maneuvers it is taken from an auxiliary compressor, also supplied by Messrs. Reavell & Company, which is driven by an electric motor of 200 brake horsepower and which can serve as a spare for one of the compressors on the main engines.

AUXILIARIES

For working this compressor and for generating electricity for the auxiliary machinery, steering gear, winches, lighting purposes, etc., there are installed two four-stroke Diesel engines, each normally developing 200 brake horsepower at 225 revolutions per minute. These motors are directly coupled to direct current dynamos working at 220 volts, while the current for lighting is transformed to 110 volts. One set is sufficient for working all auxiliary machinery and winches, so that there is always a spare auxiliary Diesel engine.

The auxiliary machinery which is electrically driven consists of two cooling-water pumps, two sets of forced lubricating pumps, two sets of bilge, sanitary and piston cooling pumps, which also handle the cooling water for the pistons. In the case of the pumps, it is only necessary to have one of each set running at the same time, so that the other is held in reserve as a spare.

Annual Convention of Lake Carriers' Association

The annual convention of the Lake Carriers' Association opened at the Hotel Cadillac in Detroit, Mich., on Jan. 21, continuing through the 22d and 23d. Directors of the Association held an executive meeting on the 21st for consideration of matters to be presented during the open meeting of the day following.

President William Livingstone, of the association, opened the convention on Thursday, the 22d, with an address covering the general work of the association during the season of 1913. Speaking upon the great storm which swept the Lakes on Nov. 9 and 10, 1913, Mr. Livingstone said that over $100,000 (£20,500) had been raised for distribution among the families of the 235 men lost during this storm, and that distribution had been made regardless of nationality or without consideration of whether the lost mariners were members of the association's beneficiary plan or not.

His address and report minimized the blame to be placed upon the Weather Bureau for failure to properly warn the vessel masters of the storm, but suggested that more specific warnings be given of the expected violence of an approaching storm.

The figures of the association show that the property loss of vessels ran up to $3,162,900 (£650,000). President Livingstone further urged members of the association to ask the widening of the Livingstone channel in the immediate future, owing to the large number of accidents occurring there since its opening. As is well known, this extremely valuable waterway provided for a down-bound channel for Lake commerce, thus separating the traffic into up and down-bound courses, and avoiding the many disastrous collisions which formerly occurred in this much-congested area of the lower Detroit River a short distance above its mouth.

Attention was also called to the new 400-foot channel between Fighting Island and the Canadian mainland, work upon which is to be commenced by the Canadian Government in the spring, and which will, when completed, permit of further separation of the up and down-bound channels in the Detroit River.

Commenting upon the membership of the association, the fact was developed that there are at present enrolled 446 vessels of all classes, with an aggregate tonnage of 2,026,082 tons, and the season just closed has been the most successful one in the history of the organization.

Further comment was made upon the proposed Wilson-La Follette seamen's bill, and an attitude of deprecation was taken upon it, the view being held that its passage would work great injustice upon both passenger and freight steamers in the United States, as well as imposing some very severe conditions upon foreign ships trading to this country, inasmuch that, as proposed, it practically legalizes desertion.

Commerce upon the Lakes is perhaps better shown by the following statement and figures than could be put forth in a long report:

During the season of navigation of the year 1913 vessel passages on the Detroit River averaged one every 14 2/3 minutes, and during the period of time from April 17 to Dec. 15 (242 days), 13,692 vessels passed the Lime Kiln Crossing at the lower end of the Detroit River. During the twenty-four hours of July 4, 162 vessels passed, which was the season's record for daily passages.

The annual banquet of the association was held upon the evening of the 22d, and practically all of the following day was given over to the meetings of the Great Lakes Protective Association, an organization of vesselmen who have combined into one society to carry their own insurance, and which includes a majority of the members of the Lake Carriers' Association.

In connection with the meetings of this association an interesting display of vessel safety appliances was made, including lifeboat models upon an improved principle, as well as specialties pertaining to both the navigating and engineering departments of steamships, and interesting in degree, as they appealed to the great variety of interests which such a meeting brings out.

Control System for the Panama Canal Locks

Power System at Panama—Location and Operation of Locks—Centralized Control and Indicating System and Mechanical Interlocking System

The complete operation of the Panama Canal locks, terminals and auxiliary equipment utilizes electrical energy throughout, with the present exception of the Panama Railroad, the electrification of which is under contemplation. The power system for the operation of the locks, towing locomotives, lights for the locks and buildings, and motors not directly connected with the lock control is composed of:

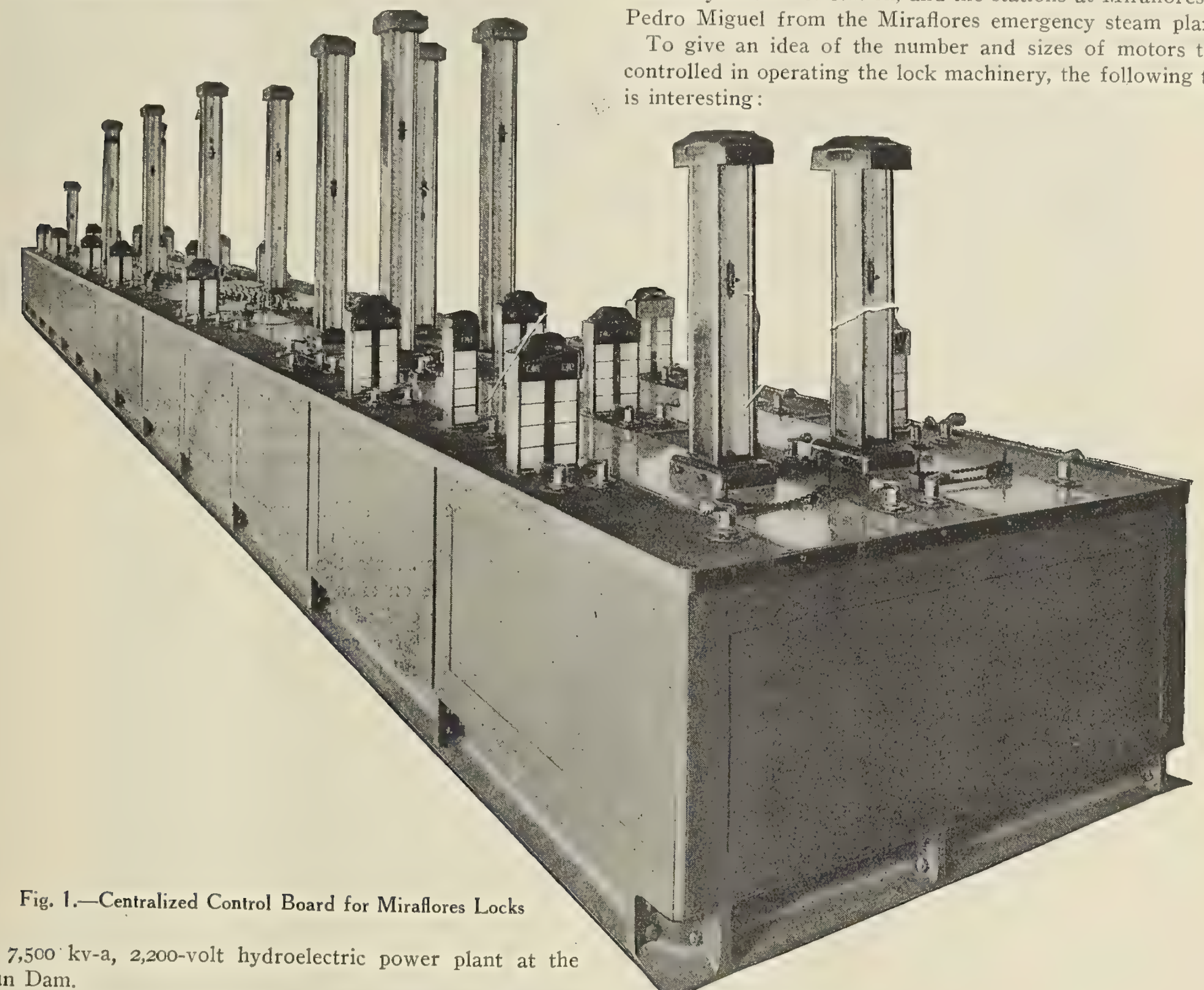


Fig. 1.—Centralized Control Board for Miraflores Locks

A 7,500 kv-a, 2,200-volt hydroelectric power plant at the Gatun Dam.

A 4,500 kv-a, 2,200-volt Curtis turbo-generator electric power plant at Miraflores for emergency, lately used to supply power for construction work.

A double 44,000-volt transmission line across the Isthmus, connecting Cristobal and Balboa with the two power plants.

Four 44,000-2,200-volt sub-stations, stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power.

Thirty-six 2,200-240-volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks.

Three 2,200-220-110-volt transformer stations for the control boards at the locks.

Stations at Cristobal and Balboa for coal handling plants, machine shops and dry docks.

Current for the lock machinery and towing locomotives is transformed from the 2,200-volt system in the immediate vicinity of where it is used. There are a total of thirty-six transformer stations, for all locks, each containing duplicate 200 kv-a, 3-phase 2,200-240-volt transformers for power and one single-phase 25 kv-a, 2,200-220-110-volt transformer for lighting. The stations, normally fed from the 2,200-volt buses in the 44,000-2,200-volt sub-stations, can also be operated from the power plants; the stations at Gatun locks from the Gatun hydroelectric station, and the stations at Miraflores and Pedro Miguel from the Miraflores emergency steam plant.

To give an idea of the number and sizes of motors to be controlled in operating the lock machinery, the following table is interesting:

Machines and Operation.	Motors each Machine and H. P.	Number of Motors. Gatun.	Ped. M.	Mira.	Tot.	Total Horse-Power.
Miter gate, moving, each leaf..	1-25	40	24	28	92	2300
Miter gate, miter forcing......	1- 7	20	12	14	46	322
Fender chain, main pump......	1-70	16	16	16	48	3360
Fender chain, operating valve..	1½	16	16	16	48	24
Rising stem gate valve........	1-40	56	24	36	116	4640
Cylindrical valve	1- 7	60	20	40	120	840
Guard valve	1-25	6	6	6	18	450
Auxiliary culvert valve........	1- 7	4	4	4	12	84
Totals		218	122	160	500	12020

There are many motors not included above, as, for instance, those for the spillway gates, for the hand rails on the mitering gates and for the sump pumps.

Location and Operation of Lock Machinery

From an operating standpoint the machinery was placed below the coping of the lock walls, thus affording a clear space

for maneuvering ships and protecting the apparatus from the weather without erecting numerous houses.

The mitering gates consist of two massive leaves pivoted on the lock walls, which operate independently of each other. A pair of gates is located where each change of level occurs and divides the locks into 1,000-foot chambers. In addition to these gates at lake and ocean ends are duplicate pairs of gates used as guard gates. To handle the vessels of various sizes with the minimum use of water mitering gates of the same description as those above are installed, dividing 1,000-foot locks into two compartments. These gates are termed intermediate mitering gates. When the mitering gates are closed they are what might be termed clamped in this position by a device called a miter forcing machine.

Fig. 2.—Water Level Indicator

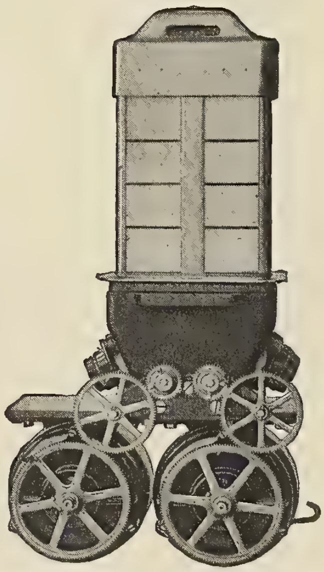


Fig. 3.—Rising Stem Valve Indicator

Chain fenders are stretched across the canal in front of all mitering gates which can be exposed to the upper lock level and also in front of the guard gates at the lower end. These chains are maintained in a taut position when the gates behind are closed, and are lowered when the gates are opened for the passage of a ship. The chains are raised and lowered by a method similar to that followed in hydraulic elevators, with the additional feature that if a ship approaches the gates at a dangerous speed and rams into the chain the chain is paid out in such a way as to gradually stop the ship before it reaches the gates. Lowering the chain for the passage of a vessel and raising it again after the vessel has passed is accomplished by two motors, one driving the main pump supplying water under pressure, and the other operating a valve which controls the direction of movement of the chain. These two operations are combined in one, each motor being stopped automatically by a limit switch when the motor has performed its function.

The filling and emptying of the locks is accomplished by three culverts, one in the middle wall and one in each side wall, the flow of water being controlled by rising stem valves. They are located in the culverts at points opposite each end of each lock so that the culvert can be shut off at any desired point for filling a lock with water from above, or upstream, or for emptying it by allowing it to flow out and down to the next lock. Lateral culverts conduct the water from the main culverts under the lock chambers and up through openings in the lock floors.

The rising stem valves are installed in pairs and each pair is in duplicate; also each culvert is divided into two parallel halves at these valves by a vertical wall. This arrangement reduces the size of each valve and makes it more easily operated, each valve being 8 by 18 feet. One pair of duplicates is left open as a guard, or reserve pair; the other pair is used for operating, so that in case of an obstruction in the culvert or accident to the machinery the duplicate pair can be used. At the upper ends of the culverts at the side walls the duplication is accomplished by three valves in parallel, called the guard valves.

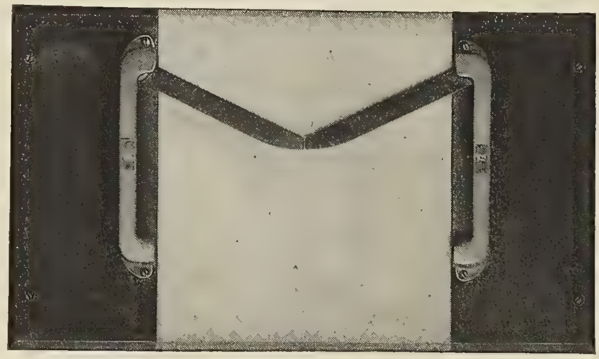


Fig. 4.—Mitering Gate Indicator

The culvert in the middle wall must serve the locks on both sides, and to control this feature cylindrical valves are placed in the lateral culverts that branch out on each side. There are ten of these on each side of the culvert at each lock.

At the upper end of each set of locks there are two valves in the side wall for regulating the height of water between the upper gate and upper guard gate, as it is desired to maintain the level of the water between these gates at an elevation intermediate between that of the lake above and that of the upper lock when the upper lock is not at the same level as the lake. These valves are called the auxiliary culvert valves.

Reasons for Using the Control System Adopted

As the flight of locks at Gatun, for instance, extends over approximately 6,200 feet, and the principal operating machines are distributed over a distance of about 4,000 feet, it can be readily seen that central mechanical transmission of control of machines would be almost impossible; and to control the machines locally would mean a large operating force distributed practically along the full length of the locks, which has invariably been the practice heretofore. Such a force would be difficult to co-ordinate into an efficient operating system. The situation therefore resolved itself into centralized electrical control, which reduces the number of operators, operating expense and liability to accident. To accomplish this system of control a control board for each lock was constructed, which permitted having all control switches located thereon mechanically interlocked, so as to minimize, if not entirely prevent, the errors of human manipulations.

Centralized Control and Indicating System

The control boards are made approximately operating miniatures of the locks themselves, and are arranged with indicating devices which will always show the position of valves, lock gates, chains and water levels in the various lock chambers; and with the exception of such machinery as needs only an

"open" or "closed" indication, the indications will be synchronous with the movement of the lock machinery.

For such indication, appliances with commutators, multiple contacts or ratchet mechanisms would not be suitable, because of the many contacts and small pieces in their construction, and particularly because devices of this character move step by step and would not indicate all points in the movement of the main machinery, such indications being more or less approximate according to the number of steps in the indicating devices. The indicators on the Panama control boards were developed especially for this undertaking, and show accurately and synchronously every movement of the machinery to which they are connected, whether in the extremes of travel or at any intermediate point. A complete synchronous indicator consists of a transmitter located at and operated by the machine in the lock wall, and a receiver operating an indicator at the switchboard in the control house.

In the case of the mitering gates, the indicator comprises a pair of aluminum leaves, shaped to correspond to the plan view of the top of the gate, which travel horizontally just above the top of the board, the hinge ends being connected to shafts extending down through the surface of the board, where they are geared to the receivers by means of bevel gears. When the miniature gates are completely opened they are covered by shields to give the effect of the gates folding back into recesses in the lock walls.

For the chain fender, the indication on the board is given by a small aluminum chain, which, like the large chain, is raised and lowered, each end operating independently, the large chain being lowered to the bottom of the lock and the small chain into a slot on the control board. The ends of the miniature chain are fastened to semaphore arms, which are connected to segmental gears meshing with the driving gears on the receiver machines. As the receiver rotors turn, the chain is either lifted or lowered, the position of the large chain from the bottom of the lock being indicated by the angle of the semaphore arms.

As the rising stem valves occur in pairs, their position indicator machines occur in pairs also. Each indicator is similar to a small elevator, a car being used to indicate the position of the valve gate.

Water Level Indicators

The specifications covering the water level indication required an accuracy of 1/20 of a foot or 1/10 of 1 percent in actual water level. The required accuracy was obtained by two sets of transmitters and receivers, one set connected to a fine index in which the rotors make ten complete revolutions and the other set connected to a coarse index operating less than 180 degrees.

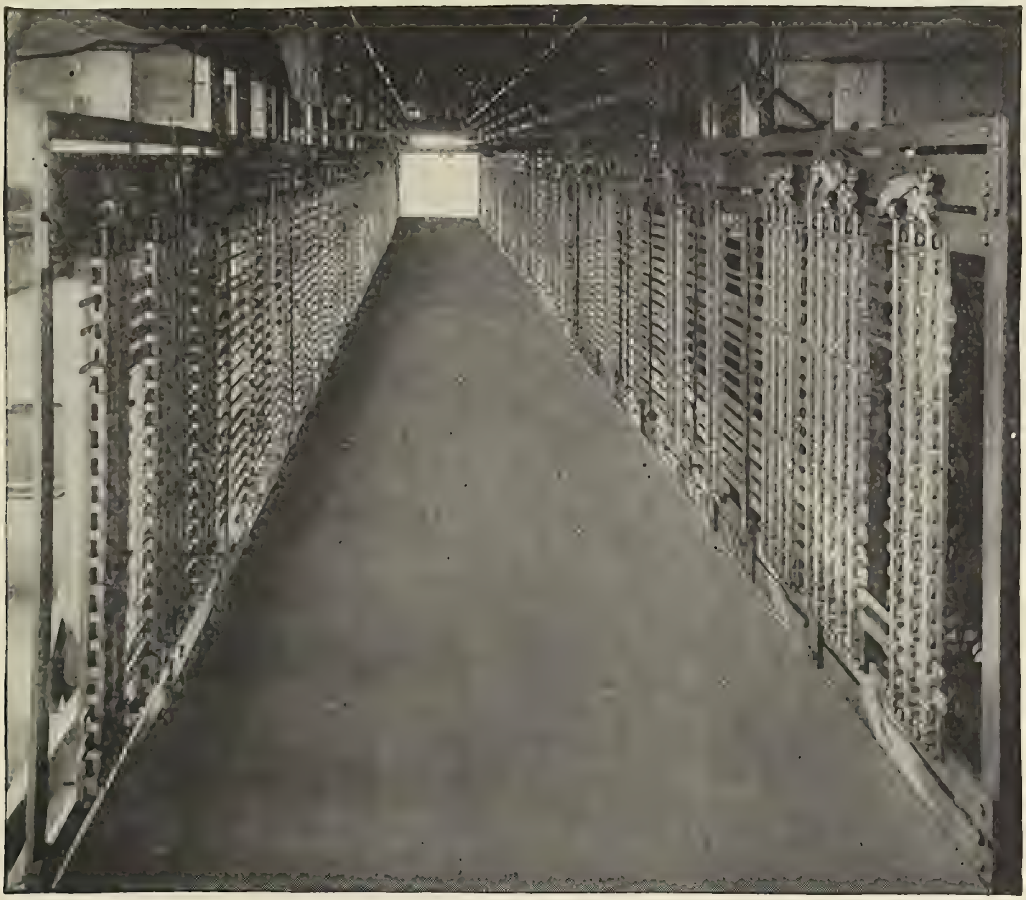


Fig. 5.—View Under Miraflores Lock Control Board, Showing Interlocking Racks

The position of the miter forcing machine is not indicated by synchronous indicators, but its open and closed positions are shown by red and green lights and a mechanical indicator on the control board representing the machine.

Control Boards Represent Locks in Miniature

The control boards are of the flat top benchboard type, 32 inches high by 54 inches wide, built in sections, with total lengths as follows:

Gatun	64 feet
Pedro Miguel	36 feet
Miraflores	52 feet

The side and center walls of the locks are represented by cast iron plates and the water in the locks by blue Vermont marble slabs. The outer edge of the board is surrounded by

a brass trim rail, and the sides are enclosed with steel plates, which can be readily removed for inspection of the board. The control board is supported by a wrought iron framework resting on base castings, which are in turn supported on the operating floor of the control house.

The control switch handles are mounted above the surface of the board and operate through an angle of 90 degrees. They are provided with nameplates for the "open," "closed" and "off" positions. The space immediately below the flat top of the control board is occupied by the contact fingers of the control switches, mounted on the operating shaft, synchronous receivers and their cable connections. Connection boards are provided for the cables, which are led up from each side, as are buses for supplying current to the control switches, receivers and the lamps that illuminate the scales of indicators. The receivers, transmitters and lamps are operated at 110 volts, while the control circuits are 220 volts, both using 25-cycle alternating current.

Mechanical Interlocking System

In order to make it necessary for the operator to maneuver the control switch handles always in a certain order corresponding to a predetermined sequence of operation of the lock machinery, and to prevent the operator in control of one channel from interfering with the machinery under the jurisdiction of the operator controlling the other channel, these control switches are provided with interlocks. The interlocks are in two vertical racks under each edge of the board and some distance below, so that they may be inspected and oiled from a floor which is about seven feet below the floor on which the switchboard operator stands. Vertical shafts operated by connecting rods from the control switch shafts extend downward past the electrical parts for the operation of the interlocks. The interlock system is essentially a bell crank mechanism connecting the shaft of the control switch through a movable horizontal bar to a vertical operating shaft, which can or cannot move according to the relative positions of the interlocking bars and dogs.

The interlock system depends mainly on the action of engaging bevel dogs located on horizontal and vertical bars, the movement of a horizontal bar tending to lift a vertical bar by bevels on the dogs. A horizontal bar cannot be moved without raising a vertical bar. Thus, if at any time a dog on a horizontal bar rests against the upper end of a dog on a vertical bar, no movement of the horizontal bar where the dog engages with the vertical bar can take place, and the control handle connected to that particular horizontal bar is locked.

Interlocks prevent the chain fender from being lowered until adjacent mitering gates have been opened, and also prevent the gates being opened until the chain is in the raised position. In this way it is assured that the chain fender will always be in the up position to protect the gate when the gate is closed. To avoid unnecessary complication, each end of the chain is interlocked with the leaf on its side of the lock only, because as a rule both leaves of a gate, as well as both ends of a fender chain, will be opened simultaneously, and further interlocking is unnecessary. After the mitering gates are closed, a miter forcing machine is operated by a control handle and locks the ends of the gates closed. This machine cannot be operated until the gates are closed.

Also the rising stem valves of the side wall, next above or below a miter gate, must be closed while the miter forcing machine is open. As the miter forcing machine cannot be closed until the gates are closed, this means that the valves either above or below the gate must remain closed until the gate itself is closed, thus preventing the operator from creating a current of water around the gates while they are open, or being moved in opening or closing. This interlock is not included on the middle wall valves, for the reason that they will be used with the locks on either side and must be free for that purpose.

Either pair of rising stem valves may be opened first, at the choice of the operator, an interlock becoming effective when the first valve of the second pair of duplicates is opened. This is done by a novel arrangement of equalizing levers acting against the ends of the interlock bars, with certain definite amount of lost motion, which is taken up on opening the first pair of valves, thus putting the interlocks in operation on the next pair.

The Designers and Manufacturers

The specifications for the entire generating, lock controlling and distribution system for operating the Panama Canal were prepared under the supervision of Edward Schildhauer, electrical and mechanical engineer, Isthmian Canal Commission, assisted by a staff of able electrical engineers, including C. B. Larzelere, who was closely identified with the lock control problems, and W. R. McCann with the generation and distribution of power. These specifications exhibited great care and painstaking engineering. They contained every safeguard that expert engineers could suggest, were exact and explicit in regard to the results required, yet gave proper range in the details of accomplishment.

All of the lock machinery motors, control panels, centralized control boards, power station generating apparatus, switchboards, transmission line sub-station equipments, coaling stations and practically the entire electrical equipment for the wharf terminal cranes and for the extensive permanent repair machine shops were manufactured by the General Electric Company.

Westinghouse Reduction Gears for Naval Vessels

The Westinghouse Machine Company, East Pittsburg, Pa., recently received contracts for marine gears for the United States torpedo boat destroyer tender *Melville* and for the cruising gears of the battleships *Pennsylvania* and *No.* 39.

The gear for the *Melville* will have two pinions on the horizontal center line, diammetrically opposite each other, the pinion speed being 1,400 revolutions per minute and the propeller revolutions 110 per minute. The total horsepower transmitted is nominally 2,000 per pinion.

The *Pennsylvania* and battleship *No.* 39 will each have two gears, which are connected to the main turbine shafts by disconnecting clutches, the cruising turbines being out of service at full power. Each of the *Pennsylvania's* gears will nominally transmit 1,400 shaft horsepower, and each has two pinions on the horizontal center line, the reduction being from 1,785 to 119 revolutions per minute.

The gears for battleship *No.* 39 are also for use at cruising speed only, the speed of the cruising turbines being 2,500 revolutions per minute, and that of the propellers 192 revolutions per minute at cruising speed. The horsepower of each of the cruising turbines of battleship *No.* 39 will be 2,000, and in this case a different arrangement of cruising turbines is used, there being only one cruising turbine on each shaft, instead of two as in the *Pennsylvania;* therefore each gear of battleship *No.* 39 has only one pinion.

The advantages of the Westinghouse floating frame for automatically maintaining the alinement of the pinions and gear and equalization of the tooth pressures and the compensation of the torsional deflection is rapidly becoming known by engineers, and has resulted in many orders for gears, there now being over 50,000 horsepower under construction and over 50,000 horsepower in operation.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Some Trial Trip Experiences

As it has been the lot of the writer to attend a considerable number of trial trips of vessels of very varied types, some of his experiences may be interesting and perhaps instructive. In view of the complexity of modern marine machinery it is surprising that trial-trip mishaps are not more frequent, more especially when one considers how most jobs are rushed at the finish up, although this rushing policy very often illustrates the truth of the ancient adage, "More haste, less speed."

In large vessels it is almost impossible for all the men operating the machinery to be familiar with the pipe connections, so they have to rely very largely on the nameplates attached to the various valves, and misplaced nameplates are a frequent source of trouble. The writer vividly remembers the trials of a certain torpedo boat which affords an example of this.

After leaving the builders' yard and on approaching the measured mile the engines were gradually opened out and the signal sent to the stokehold for "more steam." The reply at once was a demand for "more feed," as the main feed pump was in the engine-room. The pump was speeded up and in a few minutes "more steam" was again asked for to meet the increasing requirements of the main engines. The reply was as before, "more feed." The feed pump was now going for all it was worth, but the stokehold people kept the telegraph going continuously with their demands for "more feed" till they finally signaled "stop."

The engines were stopped, the silent blowoff opened and we hurried up on deck to find the stokehold crowd tumbling out of the scuttles as fast as they were able. They had watched the water dropping in the gages despite their appeals for "more feed" and when it had quite disappeared they had drawn the fires as far as possible, put on the extinguishers, speeded up the fans and cleared out. An investigation was made at once and the cause of the trouble soon located.

A filter was fitted in the feed discharge system with an arrangement of valves whereby the feed water could go through the filter or bypass it, as required. In addition, there was a connection which reversed the flow through the filter and washed any sludge or dirt into the bilges. It was found that the nameplates on the valve controlling the feed passing through the filter and that on the sludge connection valve had been interchanged, with the result that the feed water had been passing into the bilges and was not reaching the boilers at all.

Another case of the same sort occurred on the preliminary trials of a cruiser. The trial had not been long in progress when the feed tank commenced to overflow and all speeding up of the feed pumps failed to stop it. So much water was lost that the trial was abandoned and on investigation it was found that the nameplates on the feed pump suction valve chests had been reversed so that instead of drawing from the engine feed tank the pumps had been taking their water from the reserve feed tanks in the double bottom.

Another case was that of a vessel in which the starting and drain cock gear had all been dismantled during an extensive overhaul. When the overhaul was completed a turn was taken out of the engines and it was found that even with the regulator full open the engines only just moved slowly over the centers. Eventually it was discovered that by some means the "open" and "shut" nameplates at the throttle valve lever had been reversed, the throttle valve in its shut position being sufficiently open to enable the engines to move, although slowly.

By far the commonest result of rushing a job is found in badly made and leaky joints, and the engineers who take some jobs to sea must have anything but a happy time from this cause.

One cause of trouble which sometimes crops up (and which will no doubt be familiar to most engineers) is the omission to cut the center out of a joint.

The writer remembers as an apprentice a case of this kind where the center was left in an insertion joint in the main inlet pipe to the circulating pump. In consequence of this the condenser was so badly cracked on starting up that a new condenser with back columns had to be supplied.

Accidents sometimes occur through articles being left in the cylinders. In most cases a very careful examination is made before closing up the cylinders, but trouble may come in from the steam pipes. An instance of this took place on the trial of a large twin-screw vessel at which the writer was present. When on the measured mile a terrible banging started up in the high-pressure cylinder of the port engine. The engine was stopped at once and as soon as possible the cylinder cover was lifted, when it was found that the piston was smashed. The vessel returned with the power from the other engine to the builder's yard, where the piston was removed and a chisel was discovered in the bottom of the cylinder. Fortunately, the cylinder bottom was intact, so that only a new piston was required.

The chisel had evidently been left in the main steam pipe after jointing it up, and had passed through the regulator valve (the seat of which was damaged) into the high-pressure piston valve. From there it had fallen down the steam passage to the cylinder bottom.

Great care is necessary when fitting out to keep dirt, grit, pieces of waste, etc., out of the system by leaving no open joints, covers or doors. At least these should be left open for as short a time as practicable, for nothing is more annoying than to have to stop a trial for a choked filter or heater, while dirt and grit in the system can do a great deal of damage to cylinders or slide-valve faces in a very short time.

An example of trouble due to "rushing" was that of an engine which refused to run on the morning trial. The trouble was soon located in the air pump, when it was found that the bucket valves had been omitted. It transpired that the night shift had left it for the day shift to do, while the day shift had assumed it done and closed up the pump.

Another incident which has its humorous side occurred on the dock trial of a cargo steamer which was completed in a great hurry. The first trouble was the failure of the vacuum. This was found to be due to the inlet grating being choked, and it was speedily cleared with a steam jet. Other minor troubles manifested themselves in the way of blowing joints, so that everyone was kept busy and worried. The climax came, however, when the reversing gear was run over to the astern position. In their new position the links got right under the middle or packing platform and lifted it bodily off the engine, to the extreme surprise of two greasers who were on it at the time. These gentlemen were deposited on the engine-room plates together with their pots of cylinder oil and swabbing brushes. It may be mentioned that their language, when they recovered from the shock, did full justice to the occasion.

A very annoying instance of the result of carelessness came under the writer's notice on the trials of an oil-fired torpedo

boat destroyer. In one of the stokeholds extreme difficulty was found in keeping a satisfactory oil pressure at the burners. Eventually a spring-loaded escape valve in the oil discharge line to the burners came under suspicion. The escape from this valve was led to the suction side of the pump, and it was thought at first that perhaps some dirt or grit had got under the valve. It was found, however, that there was neither spring nor valve in the case, so that a large proportion of the oil had been simply returning to the suction side of the pump and bypassing the burners altogether.

Mishaps directly traceable to faulty workmanship are seldom met with in connection with the work of firms who have a reputation to lose, but the following incident, which took place on the trials of a small coasting steamer with a single triple engine, may perhaps be placed in this class.

Everything was going smoothly and the vessel had been run once over the "mile," when, without warning, the engine suddenly pulled up. The starting valves were manipulated, but the engine refused to move. It was suggested that the high-pressure slide valve had somehow moved on its spindle, but inspection showed it to be quite secure. The anchor had to be dropped and everyone moved round the engine, trying to locate the trouble, but without result. An attempt was being made to investigate the regulator valve, when the designer of the engine noticed something peculiar about the position of the high-pressure crank, and this soon led to the solution of the mystery.

The round keys securing the crank webs to the shaft had, for some reason, not been fitted, the only security being the shrinking. Thus, after running quite well for some time, the high-pressure crank had slipped forward sufficiently to neutralize the angle of advance of the eccentric—a very simple explanation of what seemed quite mysterious at the time.

The most exciting trials at which the writer has been present were those of naval vessels fitted with high-speed reciprocating machinery. The greatest degree of discomfort was reached with the engines of torpedo boat destroyers. In those days the full power trials of these vessels were of three hours' duration, against the eight hours now required by the British Admiralty. It was, however, a very strenuous three hours and no one who went through them was ever heard to complain about the three hours being too short.

The water service, usually augmented by a hose or two, was in constant operation, so that everyone was soaked to the skin, while the air seemed full of oil and sea water thrown off by the flying gear. The roar of the engines at top speed was rather trying to the nerves, while the vibration, especially when the two engines got into step, made one wonder how the ship held together. In addition, the bilges had a way of quickly filling up, with the result that the aftermost cranks would send a continuous shower of water across the engine-room. Everything depended on lubrication and the slightest failure in this direction usually finished the trial in a shower of molten white metal.

When things happened with these engines they happened quickly. Thus an eccentric strap that had been running quite cool might heat and seize so suddenly that before anything could be done the valve gear would be wrecked and the eccentric rods almost twisted into knots. Although masterpieces of engineering in their way, no one can regret that reciprocating engines are no longer fitted for this class of work.

The conditions imposed by the British Admiralty for the conduct of the trials of the last reciprocating engines fitted to battleships and cruisers were exceptionally severe. A limited number of men were specified to attend to the engines, no water service was allowed and no more oil for the bearings than that supplied by the service lubricators. It can be readily understood that the job of getting naval engines with their high speeds and bearing pressures through an eight-hour trial under these conditions was not always an easy one.

With the adoption of the steam turbine all that was changed and the trials of high speed vessels have become tame affairs compared with the conditions which obtained with reciprocating engines. Thus the writer some time ago attended the trials of a turbine-driven vessel where at one time there were only four men in the engine-room, in which about 30,000 shaft horsepower was being developed. When one considers what the maintenance of a corresponding power with reciprocating engines would involve, one cannot but be struck with the change.

Serious breakdowns with turbines are not common, especially on trial trips, where the men handling them are usually experts. When troubles do occur on a trial they are more frequently in connection with the lubrication or the vacuum. These two are most vital points in the running of turbines.

The slightest failure in lubrication is disastrous, as the writer can testify from more than one personal experience, and it pays an engineer to give great attention to his forced lubrication pumps, so that there is no liability of these pumps to "stick." In addition, the designers who arrange the machinery should endeavor to place these pumps in a position where they can be readily seen and their working observed. The best place is usually close to the starting gear, where the engineer is stationed.

A case which occurred on one of the earlier turbine-driven vessels may be mentioned. A cock was fitted at the oil inlet to each bearing, and in passing into the tunnel (where the space was very restricted) one of the greasers must have knocked against a cock handle, thus shutting off the oil supply to one of the after bearings. In a very short time the bearing ran out and the rotor dropped, thus causing a complete blade strip. With later turbines, however, it is usually impossible to completely shut off the oil supply to any bearing except by a stoppage of the pump.

Economy on a turbine-driven vessel depends to such an extent on the vacuum obtained that careful attention to this point on the preliminary trials may save a great deal of trouble later on. A good plan is to go over all the joints subject to the vacuum with thin red lead paint while they are under vacuum.

Tracing the cause of a low vacuum is often a tedious job and the most obvious places are the escape valves on the condenser and the valve which controls the turbine drain to the bilge. These may be tested with a flame. Another common cause is the leaving open of a drain cock on the exhaust valve of some auxiliary engine, and it is extremely annoying, after hunting round the engine-room for the cause of the trouble, to find it in, say, the open drain cock of the capstan engine exhaust valve. When (as in naval vessels) the closed exhaust system is used it becomes a simple matter to discover an open drain, for all that is necessary is to screw up the spring of the valve admitting the auxiliary exhaust to the condenser, thus putting a back pressure on the exhaust system. With a pressure of, say, 20 pounds per square inch in the system the open drain cock discovers itself.

The mention of the closed exhaust system reminds the writer of an incident illustrating the necessity of familiarity with the various connections which happened on the preliminary trials of a certain naval vessel. On returning to the dock after the trial, "stop" was rung down to the engine-room and steam was shut off the turbines accordingly. Greatly to the surprise of the engineer in charge, the turbines continued to revolve and it was only after some minutes of strenuous tearing round that he remembered about the auxiliary exhaust which was passing into the low-pressure turbine.

In conclusion, however, it must be said that although small but annoying examples of carelessness and forgetfulness are common enough, really serious mishaps are seldom met with on trial trips. "Reaction."

Salving the S. S. Penn

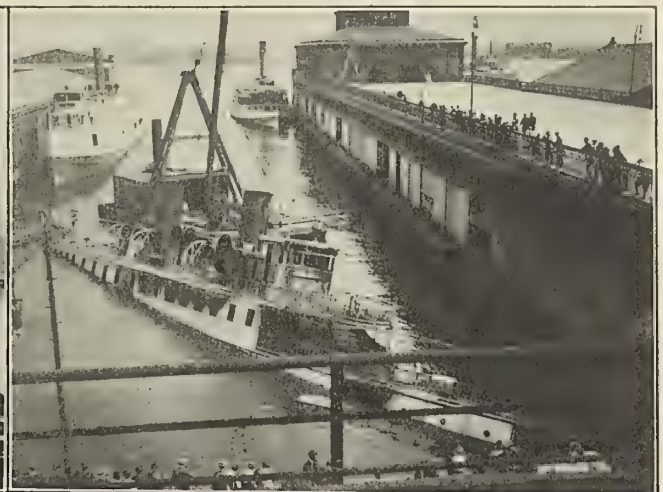
The fast day passenger steamship *Penn,* of the Ericsson Line of Philadelphia, burned and sank at her wharf, Pier 4, South Philadelphia, on Sept. 6, and, on account of the light construction of the vessel, the peculiar position in which she lay, and the character of the bottom, the salvage operations were difficult.

The *Penn* and her sister ship, the *Lord Baltimore,* were built by the Harlan & Hollingsworth Corporation, Wilmington, Del., in 1903, for their present owners, for service during the summer months between Philadelphia and Baltimore via the Delaware and Chesapeake Canal. On account of the small width of the canal locks the beam of the vessels was limited.

Their registered dimensions are 196 feet by 23 feet 6 inches by 12 feet. The propelling machinery consists of a 4-cylinder triple-expansion surface-condensing engine, with cylinders 21, 32, 35 and 35 inches diameter by 24 inches stroke, to which steam is supplied at 200 pounds working pressure by four Almy watertube boilers, which are arranged in pairs with a cross-bunker between them.

Fire broke out in the galley of the vessel about 5 o'clock in the morning of Sept. 6, and efforts made to operate the vessel's fire pump had to be abandoned on account of the heat. The flames were finally subdued, however, by two city fireboats, but in accomplishing this sufficient water was poured into the vessel to cause her to sink. Some idea of the difficulties encountered in salving the vessel may be gathered from the fact that 49 days elapsed from the time the work was begun until she was again afloat, although the wrecking company to whom was awarded the contract to raise the vessel agreed to do the work in 12 days.

Salvage operations began Sept. 12, when the wreck was examined by a diver. It was decided to raise the vessel by closing all openings in the main deck except in way of the machinery space, building a cofferdam around the machinery space from the main deck to above the surface of the water, and then pumping out the water within this cofferdam and below the main deck.



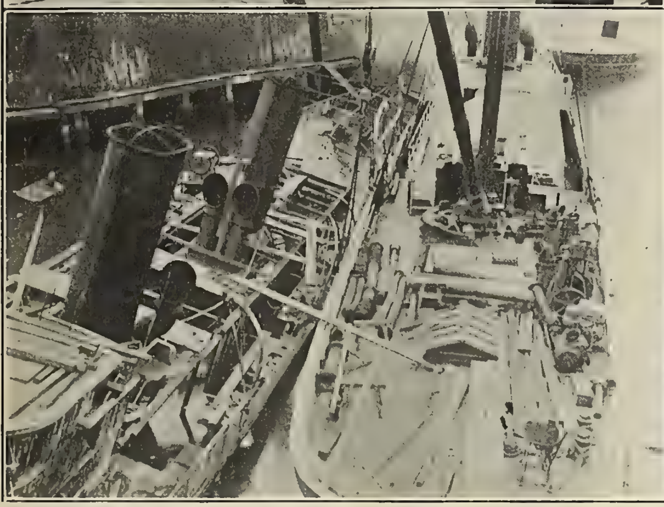


Fig. 1.—The S. S. *Penn*

Fig. 2.—Position of the Vessel after Sinking

Fig. 3.—Salvage Operations

Fig. 4.—The *Penn* Again Afloa

The shade deck was cut away amidships for the cofferdam, and it was also cut away forward of the pilot house for the installation of a pump on the bow. Two duplex pumps were installed in the engine-room near the after end of the cofferdam with discharges over the starboard side, and two centrifugal pumps were installed in the cofferdam forward of the after boiler with long suctions.

The first effort to raise the *Penn* was made on Oct. 17, when the centrifugal and duplex pumps were placed in operation, and a constant pull was maintained on a sling placed around the vessel aft and carried to a wrecking steamer alongside. About 1¼ hours after low tide, however, the water started to come in over the aft port corner of the cofferdam and work had to be stopped. After making various improvements and raising the lower corner of the cofferdam about a foot, another attempt to raise the vessel was made on Oct. 19, but proved unsuccessful.

A third unsuccessful attempt was made on Oct. 20, and a fourth effort was made on Oct. 24, all five of the pumps being operated and with the wrecking steamer exerting a pull at the stern directly on the port side. As the result of this attempt the bow came up several feet, but the stern remained fast, so on the next day an additional centrifugal pump was installed forward of the others in the cofferdam, and on Oct. 26 the fifth attempt was made, with all six pumps operating, and with the wrecking steamer and a wrecking lighter exerting an upward pull aft.

A sixth attempt to raise the vessel failed on Oct. 27, and another centrifugal pump was placed in the aft port corner of the cofferdam. With all pumps working and the two lighters pulling up on the port side a seventh attempt was made on Oct. 30, with the result that for the first time the stern was raised, but when it left the bottom the vessel started to turn over to port, notwithstanding the upward pull on that side, and the attempt had to be abandoned.

The eighth and successful attempt to raise the vessel was made on Oct. 31. The conditions were the same as on the previous day, except that the bow was not allowed to come up so high. Fig. 4 shows the vessel after she was again afloat.

Philadelphia, Pa. SURVEYOR.

Strength of Columns

The November issue of INTERNATIONAL MARINE ENGINEERING contains a reply by Mr. Anderson to a criticism which I was led to make in a previous issue regarding the validity of the Moncrief formula, together with a counter-criticism of a column formula suggested by myself. I believe that Mr. Anderson should be credited with the motive of wishing to remove any misconceptions existing with respect to the column tables, for which he stands sponsor. It seems strange to me, therefore, that he should have so entirely misread or misunderstood the reasoning in the articles which he criticises.

Mr. Anderson's stricture centers upon the method of eccentrically applying the load to a column, and on the existence or non-existence of reactions at the head and foot of the column induced by such a load. The present explanation will be made clearer by reproducing a part of his first figure (Figs. 1 and 2).

At the outset, let me say that my formula assumed the kind of loading depicted in Fig. 1, only Mr. Anderson omitted the reactions which I have indicated by the broken line arrows, which then makes the figure identical with Fig. 1 of my previous article.

Consider the stability of the column shown in Fig. 1. Can there be any possible doubt that for the equilibrium of the column acted upon by the forces indicated we must have

$$F \times L = W \times \epsilon$$

where F is the magnitude of the induced equal and opposite reactions at the head and foot? Yet Mr. Anderson says that this condition neglects the resistance to bending of the column itself as a part of the static conditions producing equilibrium. It should surely be obvious that the resistance to bending, and all internal reactions, have nothing whatever to do with, and have no influence upon, the equilibrium of the external forces.

In my article I claimed that there must, in general, be reactions at the head and foot of an eccentrically loaded column. To quote verbatim: "As unless the load was applied through the pins and those were not only eccentric, but by a miracle of chance lay in the same vertical line, there would be lateral reactions at the pins." Now Fig. 2, which illustrates the method of applying the load adopted by Moncrief, obviously assumes that the miracle has been performed. It never occurred to me that under these conditions there could be any lateral reactions at the pins. I think that anyone could see at a glance that unlike the case of Fig. 1 there are no unbalanced external forces, and therefore no reactions are required to be induced to bring the system to equilibrium.

Your correspondent thinks there might be a lingering doubt about this point, and covers half a page with a mathematical argument upon the subject. Unfortunately, however, the argument is based upon the internal bending reactions of the

Fig. 1

Fig. 2

column, which have not the slightest relation to the matter. If Mr. Anderson was to apply the two forces "T T" shown in his figure, what would happen is, that the column would begin to travel sideways with a velocity depending upon the magnitude of the forces.

"T T."

There are, in fact, in my article no misconceptions whatever regarding the reactions. The difference between the formula of Moncrief and that suggested lies in the way the

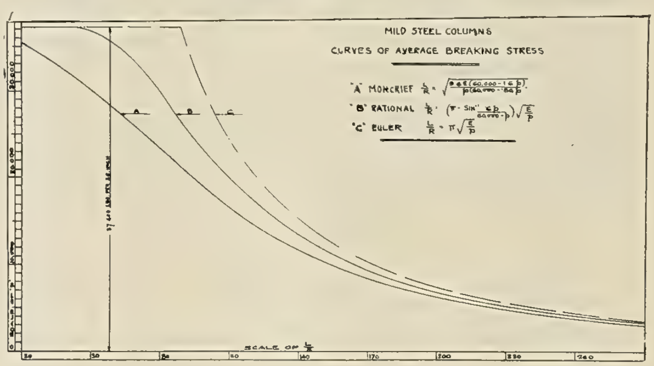


Fig. 3

load is applied, and it is here that I consider his premises to be misconceived.

Mr. Anderson claims that the method of applying the load used by Moncrief gives the worst condition. To bring in the conception of worst conditions in this case leads to a fallacy. There can be no question of worst condition, as the breaking load is compared with experiment and the magnitude of the eccentricity adjusted to make the formula agree with experiment. The question is, which method the more nearly represents actual conditions?

It seems to me that in practice there is sure to be a want of alinement of the actions of the loads at the ends. Now Moncrief has assumed that there is a perfect alinement, for the

purpose no doubt of eliminating these very reactions discussed above. It does not appear that this avoidance of the terminal reactions simplifies matters. Moncrief assumes an arbitrary form for his curve of elastic deflection:

$$Y = \frac{W L^3 \epsilon}{8 EI - 5/6 W L^2} \left(\frac{L^2 - 4 x^2}{L^2}\right) + \epsilon$$

The symbols have the usual meaning.

Had Moncrief determined the curve of elastic deflection for the premises he himself assumed, the expression would have been

$$Y = \epsilon \left(\text{Cos } nx + \frac{1 - \text{Cos } nL}{\text{Sin } nL} \text{Sin } nx - 1 \right)$$

where

$$n = \sqrt{\frac{W}{EI}}$$

The corresponding curve in the proposed formula, which included the indicated end reactions, was

$$Y = \epsilon \left(\frac{\text{Sin } nx}{\text{Sin } nL} - \frac{x}{L} \right)$$

which is simpler in form.

In practice and especially in ship work there is sure to be a more or less want of alinement. If there was no eccentricity there would be no alteration in the bending movements, due to the forces not being in line, as the direction of the resultant of the load and pin reactions would coincide with the axis of the column; but where there is eccentricity of loading the pin reactions will modify the bending movement, as previously explained.

The usefulness of a column formula based upon a conceived eccentricity of loading depends upon *the possibility of making the curve of breaking loads, as represented by the formula, agree with the curve of breaking loads determined by a wide range of experiments, by means of giving to the eccentricity factor a certain fixed value.* The form of the breaking load (unit average load) given by the formula

$$\frac{l}{p} = \left(\pi - \text{Sin}^{-1} \gamma \frac{p}{f - p} \right) \sqrt{\frac{E}{p}}$$

was found to agree with a large number of experimentally obtained curves to a remarkable degree. In Europe, it is still customary to use Euler's Formula for columns, i. e.,

$$\frac{L}{\gamma} = \pi \sqrt{\frac{E}{p}},$$

for loads less than that which would cause the material to fail by pure crushing. Euler's curve, together with Moncrief's and my own is shown in Fig. 3. It will be seen that the Moncrief formula supposes the bending effect to be influential, however short the column, while my own curve lies between this evident extreme and that of the sharply defined change point given by the Euler curve.

So much for the basic formulæ. The real object is to derive suitable column tables. Truth compels me to say that the present tables are far from satisfactory. In the first place, I think it was an error to base the constants upon the lower limits of the experimental data, instead of averaging these in the orthodox manner. This I take to be the initial error, and it looks as though to "get back" a peculiar juggling of the factors of safety had been resorted to. The nominal factors of safety given over each column are really 10/6 times the ordinary breaking load factor in common use. This is justified by stating that, keeping in view the curious manner of comparing the empirical formula with experimental data, the nominal factor of safety of the column would coincide with the true factor of safety of a tension member worked into the same structure. To use a Scotticism, the tables as they now stand are "neither fish, fowl, or guid red herring."

Assuming for the present that the Moncrief formula can be taken as a more or less satisfactory basis, then it would require only a little time to unwind the mechanism of false hypotheses and make the tables explicit. Others have found the same difficulty as myself when attempting to use these tables.

In conclusion, I do not pretend that the proposed column formula is free from fault; for instance, while the method of applying the load takes account both of eccentricity and of want of alinement, it is not the general case. The general case would, I believe, present no advantage, while being much more complicated.

Athole J. Murray.

A Novel Experience

A gunboat of the United States Navy was steaming full speed up the Amazon River shortly after the Spanish War, when a holding-down bolt of the after main bearing of the starboard engine carried away. The ship had left Manoas, which is 800 miles up the Amazon River from Para, for Iquitos, Peru, which is 2,500 miles from Para. An English tramp steamer also left Manoas at the same time for Iquitos and a race commenced between the two ships up the river.

The current of the Amazon runs at a speed of about four knots and large trees and logs were found floating down the river and occasionally the propeller blade would come in contact with a floating obstruction, with such force as to cause a heavy jar on the engine. At other times the ship would strike a glancing blow on a partly submerged object and cause alarm and apprehension in the minds of the crew as to how much damage had been done.

The two ships raced along night and day with varying success, sometimes with one ship in the lead and then again the other would have the advantage. What would sometimes appear as only a small distance separating the ships when rounding bends in the river would be a considerable distance when the ships got on a straight stretch of the river, and the excitement ran high as the ships would pass and repass each other. When the main bearing bolt broke the American ship was in the lead, with the engines making about 200 revolutions per minute.

One engine was kept going while an attempt was made to back out the broken bolt, but without success. It would also have taken some time to make a new bolt and it would have to be machined, no taps and dies of that size being at hand. The breakdown happened about 10 A. M. and the tramp steamer passed the American ship at noon, at this time making only seven knots with one engine. The end of a tow line was waved from the stern of the tramp steamer as she went by, an exultant grin on the face of the English sailor proffering the mock help.

In the meantime a one-inch hole was drilled down with the broken bolt and tapped to receive a one and one-eighth-inch stud. The bearing was replaced, a shore put under the cylinder to assist in making the job secure, and then ahead full speed on both engines.

At night the English steamer could be located by the flame pouring out of her stack. At midnight she was passed, after much jockeying for the right of way on the course and only after she made desperate efforts to keep the lead. The following morning the race ended with the American ship the winner, arriving about thirty-five minutes ahead of its rival.

Philadelphia, Pa. J. E. Cleary.

Marine Articles in the Engineering Press

The German Institute of Naval Architects, No. I.—The first paper read at the fifteenth annual meeting of the German Institute of Naval Architects, held recently, was entitled "Recent Experiences and Improvements in Marine Turbine Construction," by Dr. Bauer, engine works manager of the Vulcanwerke, of Hamburg. Dr. Bauer pointed out that while the aggregate horsepower of marine turbines built in Germany up to the end of 1906 was only 97,000, it would at the end of 1913 reach about 3,200,000. Under these circumstances lengthy experience was lacking, and many strippings of blades had occurred. These mishaps were attributed to unsuitable material, to the choice of blade proportions that facilitated bending, and to the design of the general installation, which necessitated sudden reversals. The growing tendency to increased blade clearance was emphasized as being favorable to safety in this respect, particularly if superheated steam were used. The best way to cure blade stripping was considered to be to avoid reversing the direction of rotation of the turbines, and great importance was attached to the staying of the blades so as reciprocally to support each other. Blading difficulties caused the speaker to support the adoption of the quick running indirect acting turbine, with its few blades, in place of the many-bladed direct-acting type. Quick running-geared turbines, it was maintained, would cause large reductions in cost, installation, space and weight. In comparing gearings on the toothed wheel and on the Föttinger transmitter systems, Dr. Bauer stated that while higher gear ratios and higher efficiencies could be obtained with the first method, superior reversibility and greater reliability of the mechanism were found in the hydraulic system, which provided also the possibility of developing large powers without dividing up the engine into a number of units. The percentage of engine power available for stopping a vessel fitted with the Föttinger transmitter was given as 70 to 85 percent, while that with the direct-acting turbines was set at from 35 to 45 percent only. Dr. Bauer looked forward to the use of superheated steam for installations of large power. With it and with revolutions of about 1,600 per minute, geared down to 250, a saving of about 25 percent in coal consumption would be obtained. In discussing the paper Herr Roth stated that the material used for turbine blades now in general use had been employed in many cases from the very beginning of the use of turbines, and that it was hard to account for blade strippings on the score of faulty material. Superheating was considered by Herr Roth to be an application in ship work that was undesirable. He admitted that the astern turbine was the weak point in turbine installations, but declared that suitable means had been adopted to prevent the vibration of blades, and had given good results. Dr. Bauer's assertion, that blade strippings were only caused by the reversing of the astern turbine, was absolutely contradicted. Herr Roth also favored toothed gearing, as against the transmitter system. He stated that the time required to stop a vessel fitted with reciprocating engines had hitherto been in all cases attained with direct turbine propulsion. Captain Frommann, of the German Navy, discussed the paper from the point of view of the commanding officer on the bridge with reference to the question of the maneuvering. Referring to the trials of the Föttinger transmitter system, he stated that all who had been present at its trials had seen that its maneuvering qualities were quite unsurpassed. The German naval officers were satisfied with the turbines, but, nevertheless, the stopping distance was greater in turbine ships than in the older vessels with reciprocating engines. Herr Schulthes commented favorably on electric transmission. Herr Boveri absolutely denied what Dr. Bauer had said about the astern turbine. He could not find any great difficulty in the astern turbine, but he stood on the same ground as Dr. Bauer in believing that they were on the threshhold of a change from direct to indirect propulsion, first, because of the enormous dimensions of the large turbines, in which the limit of size was reached with diameters of 5½ meters and weights of 400 tons, and, second, because the efficiency attaching to the slowly-running propellers had not been attained in direct turbine ships. He was of the opinion that from a technical point of view the toothed gearing enabled the problem to be completely solved. Direktor Eggers fully agreed with Dr. Bauer, that the natural development of turbine building lay in the direction of the elimination of the astern turbine, in gearing down and in superheating. In fact, the way seems to be open for the application of the watertube boiler with high-pressure and a high degree of superheat to merchant vessels, as well as to naval vessels, opening out excellent prospects for the reciprocating engine as well as for the turbine. Direktor Regenbogen expressed the opinion that the transmitter appliance would bring advantage only after its astern turbine had been given up and the astern turbine had been reintroduced. 4,500 words.—*The Engineer*, November 28.

The German Institute of Naval Architects, No. II.—The second paper read at the fifteenth annual meeting of the German Institute of Naval Architects was the "Development of the Submarine Boat Periscope," by Dr. Weidert, of Friedenau, Berlin. The author traced the development of the appliance from its first application to its present development, giving a comprehensive description of the various details which have been introduced to bring the appliance to its present state of usefulness and efficiency. The next paper read was on "Analogies Between Airship and Seaship Building," by the late Felix Pietzker, of the German Admiralty. The paper contained a popular description of the different types of airships and showed where points of contact occurred between them and ships that sail the seas. He showed that the airship had most resemblance to a submarine boat. The various existing types of airships were described and compared. The fourth paper discussed was by M. H. Bauer, naval architect, of Berlin, on "Harmony in the Forms of Vessels." The paper was practically a discussion of the question, "What Is the Simplest and Most Favorable Form of Vessel for Given Values of Length, Breadth and Displacement?" After a discussion of lines of various ships he finally adopted a system of sinoid and sinoid-like curves ranging in fullness from .5 to .666 for the ends of vessels, which, in combination with ordinary lengths of parallel middle body, give coefficients of displacement up to about .78. For the relation borne by the fullness of the load waterline to that of the displacement and that of the midship section, he gave a formula $\alpha = .7 \times \frac{\delta}{\beta} + .3$, in which α = coefficient of load waterline, δ = that of the displacement, and β = that of the immersed midship section. Results from the formula as applied to twenty-four vessels of widely differing types showed a remarkable agreement with the usual value. The author expressed the conviction that a geometrical treatment of a ship's lines, as attempted by Scott Russell and others, was by no means impossible, and that its application for the determination beforehand of the qualities of vessels could be made to give useful results. Baumeister Schlichting pointed out that the influence exercised by the element of form effected the displacement and the stability more than the resistance. 3,000 words.—*The Engineer*, December 5.

German Institute of Naval Architects, No. III.—On the second day of the fifteenth annual meeting of the German Institute of Naval Architects, Dr. Ing. W. Thele, of Hamburg, read a paper dealing with Hamburg dredging methods. The author traced the development of the methods and apparatus applied to the deepening and training of the River Elbe from the beginning of the last century up to the present time. A turning point in dredging practice in Hamburg was the advent of the barge suction apparatus in 1900. Each vessel was provided with a centrifugal pump for transferring material through a pipe line of several hundred yards to the shore. A second centrifugal pump was used to soften the ground and facilitate the suction operations. The Hamburg dredging plant included about 300 vessels, 65 of which were provided with steam engines and boilers, and employed about 1,000 men, including 76 officials. The next paper dealt with spark telegraphy on the *Imperator* and was read by Direktor Bredow, of Berlin. The author sketched the development of German wireless telegraphy and showed that in the race between the different systems it took a good second place to that of Marconi. The two together probably did about three-quarters of the entire work of the world. The paper was taken up mainly with the description of the wireless station on the *Imperator*, which is the largest and most powerful one installed on any merchant or passenger vessel. It comprises three arrangements of antennæ, two receiving stations and three transmitting devices capable of covering distances of 3,000, 1,200 and 400 kilometers, respectively. The apparatus is so arranged and duplicated that a part of it would be available and in working order in spite of any of the known mishaps that might reasonably be anticipated. The next paper was on the screw propeller problem by Dr. Ing. Gumbel. The paper was practically a book of over 100 pages, in which the author showed that the fundamental equations for the screw propeller corresponded with those for the turbine, the action in one being the inverse of that in the other. The condition of the flow of water in front of, behind and in the propeller and the resistance opposed to this flow were examined by the aid of equations. The assumptions made on the basis of a general consideration of the problem were then compared with the results of experience obtained in the course of propeller experiments and were found to be in complete agreement with them. A point to which the author drew special attention was that by the application of the principles laid down in the paper comparisons between propellers greatly varying in design became possible. In discussing the paper, Herr Schaffran mentioned the fact that in tugboats the broad-bladed propeller with uniform pitch was the best. He warned the meeting against transferring the conditions of one propeller to another, for enormous differences were produced by very slight alterations. The next paper was by Herr Ludwig Benjamin, of Hamburg, on the "Measure of Stability Necessary for Ships," in which he said that the measurement of stability by G. M. height was well known to be unreliable. After examining a large number of curves of levers and curves of dynamical stability of vessels of different types and sizes, he came to the conclusion that the latter gave the more convenient and reliable indication of the capabilities of the vessels selected to withstand the various heeling forces that might act upon them at sea. He proposed to establish minimum values of dynamic stability at 30 degrees and 60 degrees, and endeavored to show that these values insure the presence of stability, even when the G. M. height was made zero. This paper was followed by another on the "Importance of the Measurement of the Stability of Seagoing Ships," by Dr. I. Carl Commentz, of Hamburg, who had made experiments on board the *John Sauber* and other steamers to ascertain how far it would be possible to keep records of the stability conditions of vessels during their voyages. An instrument designed to enable measurement to be made of the angles of inclination due to the heeling of a vessel by the shifting of a known weight through a given horizontal distance was illustrated and described. Experiments with the instrument had been made by the captains of several steamers at sea, and the results had shown that with suitable inclining appliance quite sufficiently accurate results could be obtained in moderate weather and with moderate degrees of rolling. With appliances of this class, Herr Commentz considered that the captains would be able to exercise constant control on the initial stability of their vessels, and therewith of the positions of their centers of gravity. The instrument could also be used in determining the importance of list and of longitudinal trim of a vessel. 4,600 words.—*The Engineer*, December 12.

Steam Trawlers.—The first steam fishing boats were built in France in 1865. Little headway was made in the development of this type of boat until Great Britain, followed by Germany, entered the field. In Great Britain the first attempts at steam trawling were made on tug boats belonging to Tyne and Wear owners. The early trawlers were generally from 80 to 90 feet long, of small displacement. At the present time, however, much larger boats are used for this service. Modern steam trawlers may be divided into three classes: Small vessels, 90 feet to 110 feet long, intended for North Sea fishing; medium sized vessels, 110 feet to 130 feet long, also intended for North Sea fishing, but with equipment for extended voyages, and large vessels, 130 feet to 170 feet long, designed for long voyages to distant fishing grounds. Examples of these various classes are described in detail and illustrated by drawings and photographs. The scantlings of a trawler are usually from 10 to 20 percent in excess of Lloyd's requirements for an ordinary vessel of the same size. The trawling appliances on board the ship include the trawl winches for winding in and out the drag ropes, the deck fairleaders for the drag ropes, the gallows from which the otter boards are suspended when raising or lowering the net, and the towing bollards or blocks, to which the drag ropes are made fast when a sufficient length has been paid out. The arrangement and construction of these appliances are described in detail. 13 illustrations. 2,250 words.—*The Shipbuilder*, December.

The Ventilation of Modern Battleships.—By Naval Constructor R. D. Gatewood, U. S. N., and Surgeon Charles W. Oman, U. S. N. In the matter of ship ventilation the force of gravitation is the first aid to be sought. The use of electric lights has been an enormous aid in ventilation, as they add a comparatively small amount of heat and consume none of the oxygen in the air. Advantage has also been taken lately of the fact that a powerful circulation of the air in a compartment can produce results equivalent to a considerable supply of air even though no air is actually supplied to the compartment. For this reason the present unsatisfactory ventilation condition in certain fire and engine rooms would be very largely overcome by supplying a large number of ordinary circulating fans for these compartments. The present practice in designing a suitable system of ventilation for a battleship is to investigate the quantity of air required for each compartment based on the rate of change, as determined by experience for similar compartments in previous vessels, and simultaneously to investigate the amount of air required based on the number of occupants of the compartment and the character of the work customarily performed in the compartment. From these two that one is selected which calls for the larger amount of air. The ventilation of the U. S. S. *Wyoming* is described as an example. The system employed on this vessel, termed the "direct contact and ventilating system," was first tested by the navy on the U. S. S. *Vermont* in 1906 and has been extended to all ships since the *Utah* class. In general the system consists of 34 separate fans, including exhaust and supply. Air is drawn in from numerous mushroom cowls,

ventilators and trunks, located on the main and superstructure decks. Distributed over the third deck are 12 thermo-tanks forming part of the air ducts themselves. Generally speaking, the results on this ship are very good, and it would seem that this scheme of ventilation and heating combined is the right one. The minor defects encountered are pointed out and remedies suggested. 7,200 words.—*United States Naval Institute Proceedings,* September.

Explosions in Diesel Engines.—Since the autumn of 1909 there have been no fewer than eighteen reported cases of breakdowns with Diesel engines, nearly all of which were due to explosion. In order to draw attention to the risk involved from explosion in this type of engine, an abstract is given of the report issued by Mr. G. S. Taylor, His Majesty's inspector of factories, on the explosion of a Diesel engine at the Bray Electricity Station in Ireland. The nature of the explosion is described and also its principal causes and the means for avoiding such a breakdown. Another instance is cited in the case of an explosion of a blast vessel, which occurred on the *Vulcanus.* It is suggested that the observance of the following recommendations would tend to reduce the risk of explosions and accidents in connection with the running of Diesel oil engines: Compressed oxygen, on account of its intense chemical affinity for combustible gases, like hydrogen, should not be used for the purpose of recharging air vessels and a warning to this effect should be issued by the makers of Diesel engines. Definite instructions should be issued by the makers with regard to the adoption of safe methods for recharging air vessels. Only competent engineers or experienced men under the direct supervision of a qualified engineer should be employed as engine attendants on Diesel plants. Traces of oil or oil vapors should be removed as far as practicable from the compressed air before it passes into the blast vessel. Air vessels, especially blast vessels, should be cleaned and examined internally as far as practicable once every twelve months. They should also be tested hydraulically once in every four years, and the amount of expansion of the vessel under the test pressure should be carefully gaged. Some device should be fitted for preventing the transmission of flame explosions along the compressed air pipes. 1,400 words.—*The Marine Engineer and Naval Architect,* December.

Cross - Channel Steamers.—The modern cross - channel steamer is in reality a miniature ocean liner, with a very high speed in proportion to her length. Her size is limited by the volume of trade she commands, which is small per ship per run. Her length is strictly limited by harbor facilities. The breadth, which for the purpose of speed should be as small as possible, is restricted to a certain minimum by the demands of stability and also by the demands of deck space for passenger accommodations. The draft is generally fixed by harbor limitations. The question of watertight subdivisions is of great importance, due to the constant presence of danger in such service. It in turn, however, is restricted by the conflicting elements of registered tonnage, upon which depend the dues and convenient passenger arrangements. The author claims that by introducing a watertight bulkhead between the engine and boiler spaces, and by making the lower deck forward, or both forward and aft, a watertight flat with watertight trunked hatches from the holds to the bulkhead deck, the watertight subdivision of the vessel would be greatly increased without affecting the tonnage measurements. Watertube boilers have now generally superseded the cylindrical type on such vessels on account of their saving in weight, coal consumption, floor space and the time to raise steam. The system of propulsion adopted depends upon such desiderata as speed, regularity of service and, particularly, rapid maneuvering. The introduction of turbine machinery, with high-speed propellers of small diameter and with independent astern turbines of only about one-half the ahead power, has given disappointing results on account of the poor maneuvering qualities of such an arrangement, in spite of the recognized advantages of higher speeds, less vibration and saving in weight and machinery space. For this reason the various turbine reduction gears which are now being perfected offer great advantages, and the author goes so far as to claim that eventually the internal combustion engine, with its great accelerative power and other advantages which obviate the great waste accompanying intermittent full power service with steam power, will probably prove the most suitable for cross-channel work. 5 illustrations. 2,250 words.—*The Shipbuilder,* January.

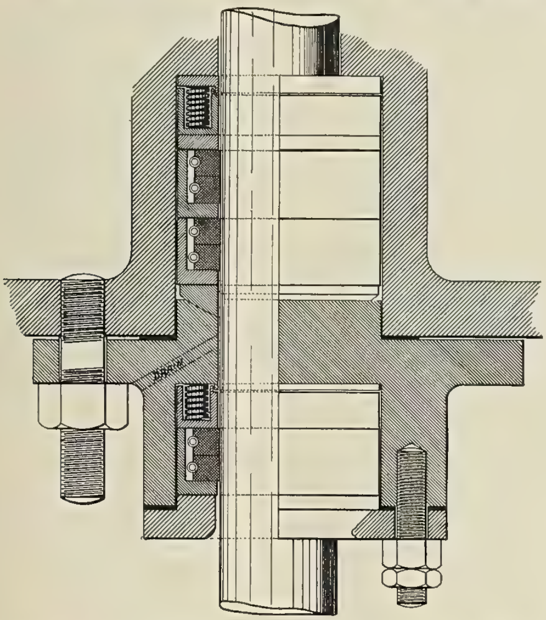
Stresses in Marine Engine Shafting.—By Ernest N. Janson. This article is divided into two parts. In the first part is shown the determination of the known stresses caused by the calculable forces, as well as the plotting of curves of combined twisting moments on shafting of actual ships. No attempt has been made to establish values for the unknown stresses, but in the second part references are made to such of the forces as to which the origin of the unknown stresses may be ascribed. Critical speed of revolution is also discussed. The known stresses discussed in Part I include stresses due to forces exerted by the pressure of the steam in the various engine cylinders; stresses due to inertia of moving parts of the engine and stresses due to bending influenced in the crank shafting by direct action of steam forces, and in propeller shafting by the weight of the propeller and the pitching of the ship. The unknown stresses discussed in Part II are torsional vibration stresses; stresses brought on by distortion in alinement of bearings, either as a result of wear in the bearings or weakness of hull, or in foundations; and stresses resulting from defects in the material or running afoul and reactions of the propeller due to pitch. Frahm's experiments disclosed that maximum twisting moments in cases where actual twist of shafting had been ascertained were for three-cylinder engines 3.3 times the mean, as compared with 1.3 times obtained by the usual method of figuring. The critical number of revolutions of the fourth order of many of the engines of naval vessels often, unfortunately, constitutes the cruising speed of the ship, although the power at this speed is greatly reduced, the stress on the shafting due to the equivalent combined twisting moment, observing the above actual ratio of $3.3 \div 1$, becomes approximately equal to shafting stresses as large as when the engine is developing full power. These stresses fluctuate between zero and the maximum value in one direction and zero and a maximum value in the opposite direction, the twisting action on the shafting being thus reversed several times during each stroke, the number depending upon the type of engine. The existence of a considerable increase of stress in shafting of reciprocating engine ships due to synchronous torsional vibration at normal or cruising speeds of naval vessels and to overload or other conditions such as constant reversal, striking of floating objects, corrosion, disalinement, etc., renders the position reasonable in assuming that shafting with a designed shear stress of 10,000 pounds per square inch of section, equivalent to probably between 14,000 and 15,000 pounds tensile stress under actual working conditions, becomes severely overstrained. This designed stress, therefore, may be lowered in the interest of greater safety, even at sacrifice of greater weight caused by increased dimensions. 11 illustrations. 9,000 words.—*Journal of American Society of Naval Engineers,* November.

PERSONAL.—Capt. E. W. Barlow is now associated with Cox & Stevens, naval architects, New York City, in charge of their commercial vessel brokerage department, taking the place of Mr. H. Matteson, formerly with this firm.

ENGINEERING SPECIALTIES

Katzenstein's Improved Automatic Metallic Packing

L. Katzenstein & Company, New York, has on the market a patented improved automatic metallic cup packing, a sectional view of which is shown in the illustration. This packing is designed for use on all kinds of marine and stationary engines carrying very high pressure, and also on pumps, air compressors, etc. It is designed to hold tight against very high pressure with little friction, and also takes the vibration of the rod, and can be put in ordinary existing stuffing boxes with little change in the construction of the gland. If the metallic packing should give out, the gland is so constructed that the packing can be removed and the stuffing box repacked with fibric packing without change of gland and with little delay in the operation of the engine. A drain is provided to



carry off any condensation of steam which may occur. A metal gasket or copper rings prepared for the purpose is interposed between the gland and the stuffing box, and the gland is screwed down, making a steamtight joint. This gland carries an auxiliary stuffing box in which an additional section of metallic rings is placed for the purpose of holding back any leakage which might pass the drain.

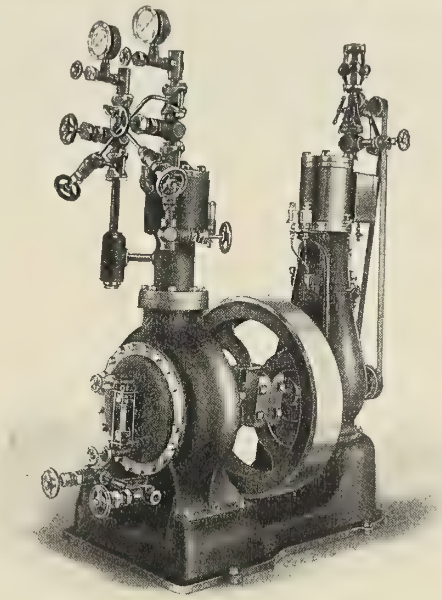
The packing consists of a series of white metal bearing rings carried in cups. At the top of the main set of packings are two rings having a spherical joint, which, it is claimed, takes up any vibration which may take place in the rod. The white metal rings are cut in three or four parts and are held in place by means of a helical spring. The hook and eye at the end of this spring are made of a special grade of steel to a special design, which, it is claimed, eliminates all danger of breaking. If the stuffing box is of sufficient depth, three cups or more of white metal rings are used. The function of the spring plate is to set the packing and make it adjustable and automatic. The last ring is to hold the spring in position and to prevent parts of springs, should they break, from coming in contact with the rod.

This packing can be constructed to suit any stuffing box. In cases where stuffing boxes are shallow the top ring might be left out and the ball ring fitted directly into the gland. The packing is practically self-adjusting, and for this reason it is made of a smaller diameter than that of the stuffing box, which gives a floating packing which will follow the rod should it vibrate or get out of center. The bearing surfaces of the rod and packing, it is claimed, will always be in the same relative positions, and hence, after the packing has once become adjusted in a box, it will retain its full bearing surface on the rod holding the same and have a steady effect upon it with very little friction.

This packing is recommended by the manufacturers for rods of 1½ inches and over.

Refrigerating Plant for Ship's Stores

It is only in the last two or three years that it has been thought possible to install a refrigerating plant on board a steamship to take care of the ship's stores. Now, however, it is possible to equip a steamship, no matter how small or how large, with a refrigerating plant to cool the ship's stores' refrigerator or refrigerators, to make any amount of ice needed, and to cool water for drinking, all with one machine. The Brunswick Refrigerating Company, New Brunswick, N. J., has installed over two hundred machines on steamships for



this purpose, and in a few cases entire cargo holds are being refrigerated.

In the machine used for this work the ammonia compressor is direct connected to an engine of the vertical center-crank type. The compressor has an eccentric in the crank case and this eccentric and the strap which works on it, it is said, have shown no appreciable wear, even after ten years of service. This machine, together with the ammonia condenser and other apparatus used in connection with the machine, can be placed near the refrigerators, if there is room, or at some distance from them, if there is no room near the refrigerators. In a recent case pipes were run from the machine, placed amidships in the engine-room, through the shaft alley to the refrigerators, which were on the main deck aft, a run of over 200 feet each way. The ice-making apparatus can be installed near the refrigerators or near the machine, just whichever is more convenient. Cooling coils are placed in the refrigerator, and all the dirt and muss of ice is avoided, as no ice is placed in the refrigerator.

These plants, it is claimed, have proved a means of securing very great savings on the ships on which they have been installed. In one case a sufficient amount of meat, butter and eggs and vegetables was taken aboard in New York to last during a 69-day trip to the upper Amazon and back. With a Brunswick plant these goods were kept in perfect condition during the entire trip and the material served on the day the steamer arrived in New York was just as good as that served the day the steamer left. Such plants can be used advantageously for preserving the ship's stores on any type of vessel, whether it is a steamer, a dredge, a collier, an oil tanker or a yacht.

"Bisset" Adjustable Folding Canvas Chair

The deck chair illustrated, which is the invention of Naval Constructor G. A. Bisset, U. S. N., Portsmouth, N. H., can be adjusted as an ordinary upright-back chair, or it may be placed in a position in which the back and leg rest are almost horizontal. It can also be adjusted to any one of several intermediate positions.

The chair is extremely comfortable, as the head comes in contact with the canvas only, and not with the wood, as it

does with the usual type of steamer chair. The back of the chair has a curved wooden brace, which is entirely clear of the canvas, and the canvas can be removed and replaced quickly, a feature which permits the canvas to be scrubbed whenever it becomes dirty. The chair can be folded compactly into a very small space when it is desired to stow it away.

A patent for this construction has been applied for.

Special Types of Lunkenheimer Pop Safety Valves

The use of large-size pop-valves is in a number of cases not only objectionable, but in some cases a pop-valve above five inches is prohibited. It is therefore necessary to use two smaller valves having a combined area equal to that of the required large-size valve, and for this reason the constructions shown in Figs. 1 and 2 were designed by the Lunkenheimer Company, Cincinnati, Ohio. Fig. 1 illustrates the

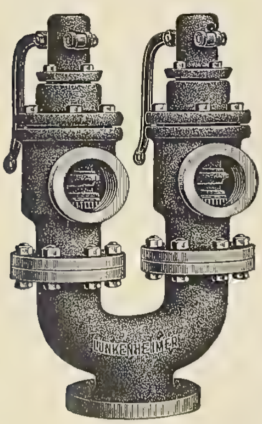


Fig. 1

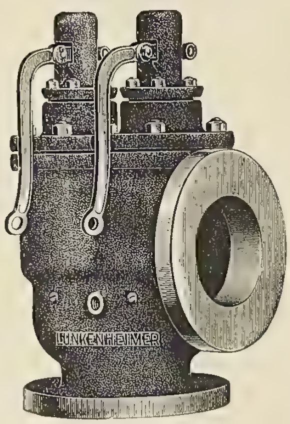


Fig. 2

"Twin" pop-valve, which merely consists of two separate valves attached to a suitable base or Y, while Fig. 2 shows the "Duplex," in which two independently operating valves are encased in one body. Both have their advantages. With the "Twin," should one of the valves become damaged beyond repair it can be replaced with a new valve at a less cost than the "Duplex." On the other hand, space may not permit of the use of the "Twin," and, consequently, the "Duplex" must be resorted to. In some cases no objection is had to the escaping steam within the boiler room, and, therefore, no pipe connection is made to the outlet. Should it be desired to have the steam exhaust at a distance from the valve, the "Duplex" would then have the advantage, inasmuch as only one pipe connection is necessary, whereas the "Twin" would require two.

Fig. 3 illustrates a type of valve generally known as the "Marine" pattern. It differs from the "Sentinel" pop-valve described in the January issue only in the addition of a wing handle at the top of the valve, the object of which is to conveniently enable the turning of the disk on its seat for regrind-

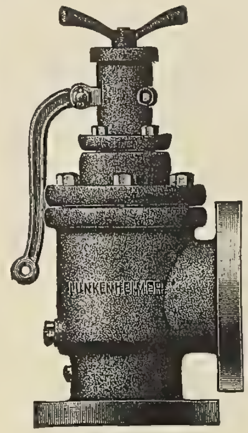


Fig. 3

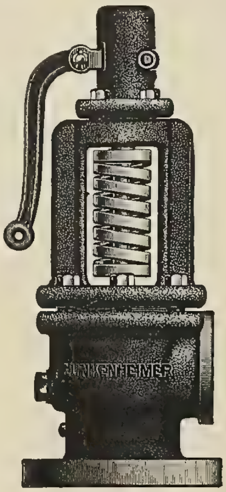


Fig. 4

ing purposes, or while the valve is under pressure to remove slight incrustations that may lodge on the seating surfaces.

An improved form of valve that is very popular is that shown in Fig. 4. In this construction the spring is exposed, the principal advantages being that the spring is positively protected from the steam and that it is at all times accessible for inspection. This valve is particularly well adapted for use where superheated steam is used, as the extremely high temperatures cause the springs to rapidly lose their tension. The construction of the working parts is practically the same as the "Sentinel" valve, shown in the January issue.

Trials of a 100 Brake Horsepower Junkers Marine Oil Engine

The Maschinebau Actiengesellschaft vorm. Gebr. Klein in Dahlbruch recently delivered a Junkers marine oil engine of 100 brake horsepower, of a type which has been specially developed for the purposes of inland navigation.

The advantages of the Junkers engine for inland navigation work, as compared with four-cycle and other two-cycle engines, are set forth by Professor Junkers as follows:

(a) Low weight, therefore shallow draft.

(b) Simple design, therefore simple attendance, which is of importance respecting the incompetent personnel often found on rivers and canals.

(c) Absence of parts, which are frequently the cause of breakdowns, i. e., scavenging valves, exhaust valves and cylinder covers.

(d) Good balancing and light load on main bearings, therefore minimum wear and no overheating.

(e) Low fuel consumption, therefore low running costs.

(f) Small initial cast.

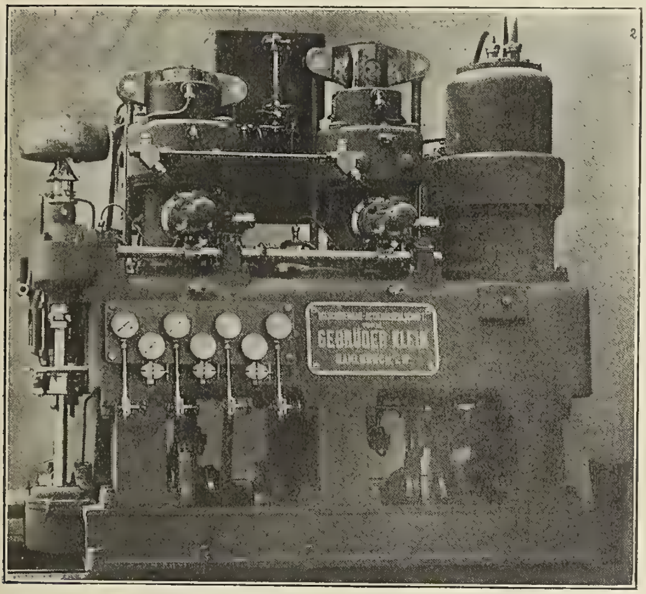
Description of the Engine

The engine has an output of 100 brake horsepower at 300 revolutions per minute. The two working cylinders and the scavenging pump are supported on and connected by a con-

tinuous scavenging air receiver. Both cylinders exhaust into one exhaust box, arranged horizontally at the rear of the cylinders. The scavenging air is delivered at a pressure of 2.2 to 2.9 pounds per square inch, the scavenge pump being driven directly off the crank shaft by a crank and connecting rod. Compressed air for the injection of the fuel oil and for starting the engine is supplied by a simple acting three-stage compressor, the second stage of which is placed on top of the scavenge pump, the first and third stages being arranged at the rear of the scavenge pump.

Each cylinder is fitted with a fuel valve, a starting valve and a safety valve.

The two fuel valves are actuated by a cam shaft running horizontally along the top of scavenging air receiver and connected by gearing to the crank shaft. The cam shaft has been



placed so close to the fuel valves that a single light lever suffices to make the connection between the cam and the fuel valve needle. The inertia effect is thus reduced to a minimum. The arrangement, it is claimed, can be adjusted with the greatest precision while the engine is running.

The starting gear is provided with an arrangement designed to prevent any fuel from entering the cylinders while the engine is starting up on compressed air.

The fuel pump is fixed to the scavenging air receiver at the flywheel end. It is driven by means of a crank in the vertical shaft connecting the cam shaft to the crank shaft. By means of a double lever both pistons are driven off the same crank. The lever also works the rods of the suction valves.

Governing of the fuel supply to the requirements of the load is effected by varying the length of time that the suction valve is open during the pressure stroke of the fuel pump. The speed of the engine can be controlled independently of the governor, directly from the running platform or the bridge, by varying the lift of the suction valve.

Seven pressure gages are arranged on the front of the scavenging air receiver; two of these are connected to the starting air bottles and two to the compressor receivers; the others register the pressure of the injection air, scavenging air and cooling water, respectively.

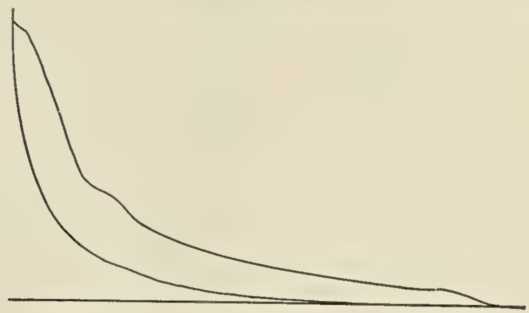
At the front end of the engine are arranged a circulating pump and a bilge pump, both directly driven by the main engine.

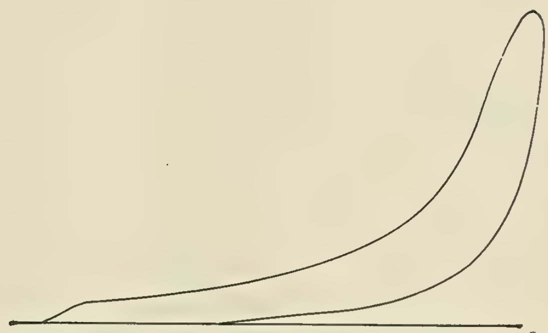
Starting the Engine

After having made certain that the fuel supply pipe is filled with oil up to the fuel valves, also that the valves connecting the air bottles to the starting airline are open, the only movement required to start the engine is to push over the starting lever to "starting" position, thus admitting compressed air to the cylinders, and after a moment, usually after two or three revolutions, the starting lever is returned to the "running" position and the engine continues to run normally on oil. Thus the whole operation of starting consists in moving a single lever once forward and back again.

The Trials

The acceptance trials required by the purchasers were run by Professors Laas and Romberg, of Technical High School, Charlottenburg, on the test bed at Dahlbruch. A 72-hour continuous trial was stipulated. The engine ran without stoppage, except for a very short time in consequence of a necessary





alteration to the testing brake, for a period of 60 hours, further trial being deemed unnecessary on account of the satisfactory results obtained.

During the trial two hours were run at 10 percent overload, which was carried by the machine in a perfectly satisfactory manner. The mean fuel consumption was .407 pounds per brake horsepower hour at the normal load of a 100 brake horsepower. The maximum output obtained was about 120 brake horsepower.

Powell "Mac" Compression Grease Cup

The Powell "Mac" automatic grease cup, manufactured by the Wm. Powell Company, Cincinnati, Ohio, is especially designed for general all-around use. It is cast of brass sufficiently heavy and well proportioned, and operates equally well on cranks, crossheads, slides and journals of all kinds, meeting the demand for a simple, easily operated, reliable compression grease cup. The plunger, or piston, has a leather packing, insuring a snug fit and preventing the grease from backing up and filling around the spring and thus interfering with its operation. It has a simple feed adjustment, and an automatic lock arrangement, which it is claimed precludes any possibility of the feed being cut off by vibration or jarring of the machinery.

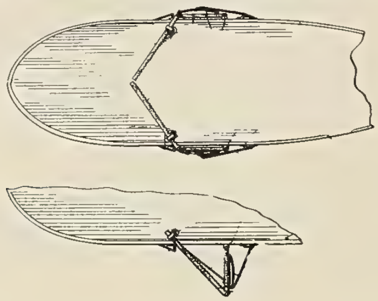
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,078,902. VESSEL EMERGENCY-BRAKE. SAMUEL S. CENTOFANT, OF SMITHS BASIN, N. Y.

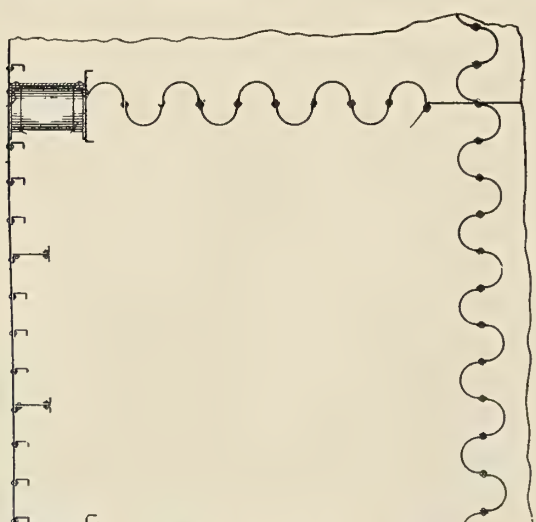
Claim.—In a brake mechanism for vessels, the combination of a hull, a leaf pivotally mounted on the side of the hull with its axis of rotation disposed vertically with respect to the hull, means for swinging said leaf to positions against and at an angle to the hull and means for bracing the leaf when the latter is disposed substantially at right



angles to the hull, said means comprising an arcuate rod disposed transversely of the leaf and having its terminals secured thereto, a U-shaped bracket secured to the hull and disposed longitudinally of the latter, and a brace rod having its terminals slidably engaged with the arcuate rod and bracket, respectively. One claim.

1,076,208. SYSTEM OF CONSTRUCTION FOR STEEL SHIPS. SAMUEL HOLMES, OF ELIZABETH, N. J.

Claim 1.—A bulkhead construction for ships involving a main longitudinal central bulkhead and transverse bulkheads connected therewith and with the sides of the hull by a bulkhead frame construction com-



posed of sheet metal formed into deep undulations or trough-shaped members which open in opposite directions and which are riveted to the hull, and between which and the bulkheads are placed web plates which are riveted thereto and to said bulkheads. Seven claims.

1,076,295. SINKING DEVICE FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 3.—In an automobile torpedo, a spring-closed exhaust-valve opening from an air chamber within the shell, and means for holding said valve open when it has been opened by the escaping air consisting of a spring-pressed dog engaging the rim of the valve and adapted to spring between it and its seat upon the opening of the valve. Six claims.

1,079,182. SUBMARINE CULTIVATOR AND HARVESTER. NELS A. LYBECK, OF BRISTOL, R. I.

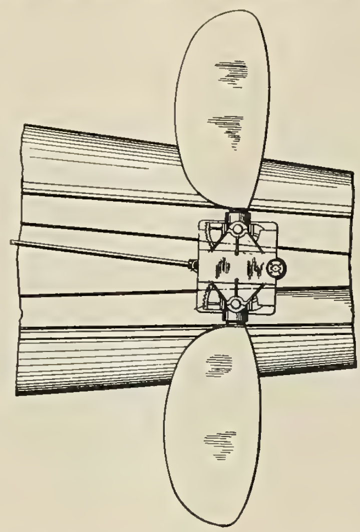
Claim 1.—In a submarine cultivator and harvester, a submarine tool having a lateral extension adapted to travel on the sea bottom; a floating vessel; a cradle mounted on said vessel from which said tool is operated; a boom pivotally connected with said cradle and said tool; a conveyer mounted on said boom, and a cover for said conveyer mounted on said boom to receive water pressure for depressing the tool bearing end thereof, when the device moves forward. Seven claims.

1,073,954. MARINE STEERING-GEAR. LESLIE CAULDWELL BURNS, OF UNION HILL, N. J., ASSIGNOR OF ONE-HALF TO CYRUS J. WALTERS BURNS, OF NEW BRUNSWICK, N. J.

Claim 1.—A motor for actuating steering gear, comprising a fluid pressure cylinder, a piston working therein, a piston rod extending beyond each end of the cylinder to afford means for an operative connection to a rudder, inlet and outlet valves opening to each end of the piston cylinder, and a geared disk, connecting rods therefrom to each of said valves and a manually controlled pinion for rotating said disk to simultaneously actuate said valves. Six claims.

1,073,100. FOLDING HYDROPLANE FOR SUBMERSIBLE BOATS. GREGORY CALDWELL DAVISON, OF QUINCY, MASS.

Claim 3.—A submarine or submersible boat, having hydroplanes swiveled thereon on vertical axes, whereby they may be turned in a

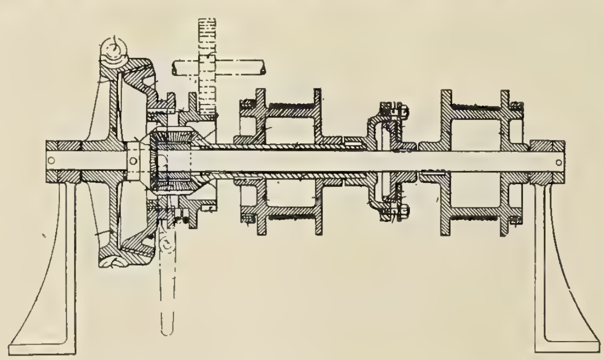


lateral sweep from an extended position of wide spread to a shipped position lengthwise of the boat, in combination with mechanism for adjusting the hydroplanes on their horizontal axes for steering. Seventeen claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

1656/1913. BOAT-HOISTING AND LOWERING GEAR FOR SHIPS. M. E. DENNY, OF LEVEN SHIPYARD, DUMBARTON, N. B.

Claim.—The invention consists essentially in the interposition between the usual falls in boat-hoisting and lowering gear and the operating means of a three-member epicyclic train, one member of which is connected with one fall, another to the other fall, and the intermediate member to operating mechanism, the object being to automatically



maintain an even keel. The falls are led to two winding drums, one fast on a shaft, the other fast on a sleeve loose thereon. To the drums are connected to two large bevel pinions of the epicyclic train and the planetary bevel pinions engaging these and carried in a spider free on the shaft. To the spider is applied the operating gear and a brake. The falls are attached to the boat at points horizontally equidistant above its center of gravity.

22923/1912. APPARATUS FOR LOWERING SHIPS' BOATS. THE MARTIN PATENT DAVIT COMPANY, LTD., OF 9 UNION COURT, LIVERPOOL, AND E. S. GLADSTONE.

Same.—The object of this invention is to enable ships' boats to be lowered on an even keel when the ship is down by the head or stern. The end of the rope of the falls instead of being fixed is led, for example, to a barrel capable of being rotated and locked in any position. The barrel is operated by a worm and worm wheel which are self-locking. By turning the barrel rope is wound upon or wound off from it, thus shortening or lengthening the fall relatively to the other fall and compensating for the inclination of the ship. The well-known Martin davits, in which the same rope is used for both falls, is preferably used.

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New London Harbor Improvement Project

The State of Connecticut Begins Erection of Large Steamship Pier at New London—Novel Type of Construction Adopted

BY WILLIAM T. DONNELLY*

In September, 1912, the writer was retained as consulting engineer to the Rivers, Harbors and Bridges Commission of the State of Connecticut, with particular reference to a project for the improvement of New London harbor, to be carried out by and at the expense of the State of Connecticut. The commission as originally constituted consisted of Edward H. Warner, Hartford, chairman; Frank V. Chappell, New London, secretary; Oliver Gildersleeve, Portland; Thomas F. Noone, Rockville, and William H. Cadwell, New Britain. The organization was completed in the fall of 1912 by the appointment of Mr. Waldo E. Clarke as resident engineer, and a preliminary investigation was at once commenced to determine the general lines and location of the improvement, which was to consist, primarily, in one or more piers with the best possible arrangement of rail and water access.

After a careful survey and consideration of the entire harbor and water front it became apparent that the most advantageous location for the improvement would be at the head of the harbor alongside and to the eastward of the Central Vermont pier. This location as regards accessibility by rail and ship is practically ideal. It will be noticed by reference to the plan that ships entering New London harbor and sailing directly up the main channel can enter and dock at either side of this pier with but a slight change of course in the entire distance, and that the pier has direct connection with both the Central Vermont Railroad, which is the Southern New England connection of the Grank Trunk system of Canada, whose main line to the Pacific is soon to be completed, and the New York, New Haven & Hartford Railroad, with its extensive connections with the Pennsylvania and other railroad systems of the United States.

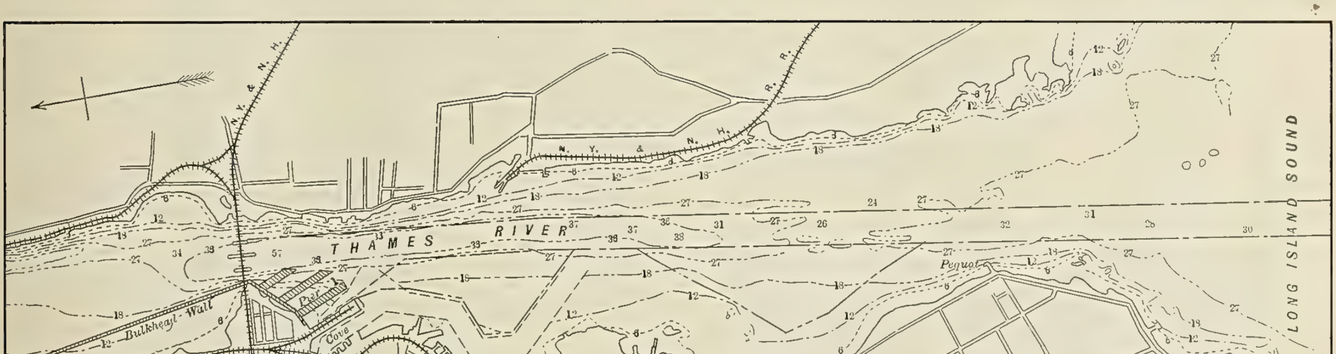


Fig. 1.—Plan of New London Harbor, Showing Location of New Pier and 35-Foot Channel

New London harbor is one of the best and most easily entered harbors on the United States coast. As a matter of fact, New London owes its name to the anticipation and hope of the early settlers that it was to rival the city of the same name with which they were so familiar, and it is still possible that this city in the future may be an important commercial gateway to the heart of New England and to Canada on the north.

As soon as this determination as to location had been reached, thorough and careful preliminary borings and surveys were carried out to determine the actual outline and location, with the general results as shown in the harbor plan, Fig. 1.

* Consulting Engineer, 17 Battery Place, New York City.

In general agreement with the recently-accepted standard of 1,000 feet as a practical working length of the larger class of ocean steamers, this length was decided upon for the first pier. Much consideration was given to the desirable width of pier, and careful investigation and comparison was made with similar work undertaken by the State of Massachusetts in Boston harbor, the city of Montreal in Canada, and also with extended developments in New York harbor, San Francisco, Cal., and Seattle, Wash. This resulted in placing the maximum desirable width at 200 feet.

at a very reasonable cost. The third consideration was the very limited area of level land for warehouse facilities and approach.

All these considerations directed towards the design as worked out; that is, the central portion of the pier, 100 feet wide, enclosed by a rubble masonry retaining wall carried on piling cut off at the low-water line; the space between these walls to be filled with the dredged material from the slip on either side of the pier; a shelf or wharf of creosoted piling, 50 feet wide, to be constructed on either side, making a total

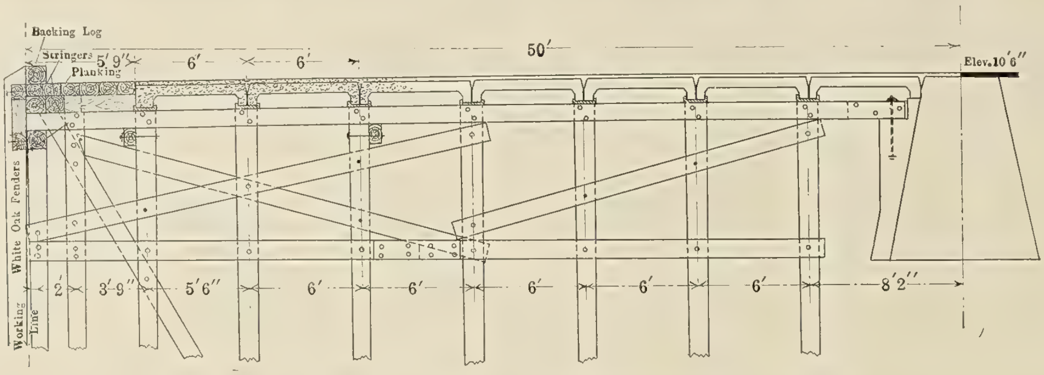


Fig. 2.—Section Through Wharf at Side of Central or Permanent Pier

In developing the particular method of construction to be used, a series of studies was made in complete detail by the resident engineer and his staff as follows:

First. The method of supporting the entire pier on steel caissons on approximately 20-foot centers, excavated and filled with concrete, with a deck of reinforced concrete and steel.

Second. A somewhat similar construction with concrete piles.

Third. A creosoted pile construction with timber caps and stringers and concrete decking with asphalt top, similar to recent developments for New York harbor piers.

Fourth. The final and accepted method as shown on general plan, Fig. 3.

This final method was the outcome, as most plans are, of certain controlling local conditions. The bottom where the pier was to be located, while of excellent material, contained occasional boulders, which would make the sinking of caissons uncertain and expensive. Another local condition was the possibility of obtaining stone for rip-rap in the vicinity

width of 200 feet; the piling to be braced and capped in practical conformity to the standard worked out in relation to pier work of New York harbor, and the slope from the foot of the retaining wall to a depth of 35 feet at low water, to be protected by rip-rap placed after the piles were driven.

In connection with the decking very careful and extended studies were made by the resident engineer to determine the best and most economic form and method of construction. This has resulted in the adoption of a block pre-molded section of concrete, carefully reinforced with steel, to carry a working load of 600 pounds per square foot. The detail construction of these blocks and the method of laying them are shown in Figs. 2, 3, 4 and 5. Reference to Fig. 2 shows that they are carried on cast iron shoes resting on the top of the piles, and it will be understood that the finished blocks or slabs will be placed upon these shoes, wedged up to a level and grouted to obtain a satisfactory bearing, after which 2 inches of asphalt paving will be laid on top. This has been found to make a very much better wearing and work-

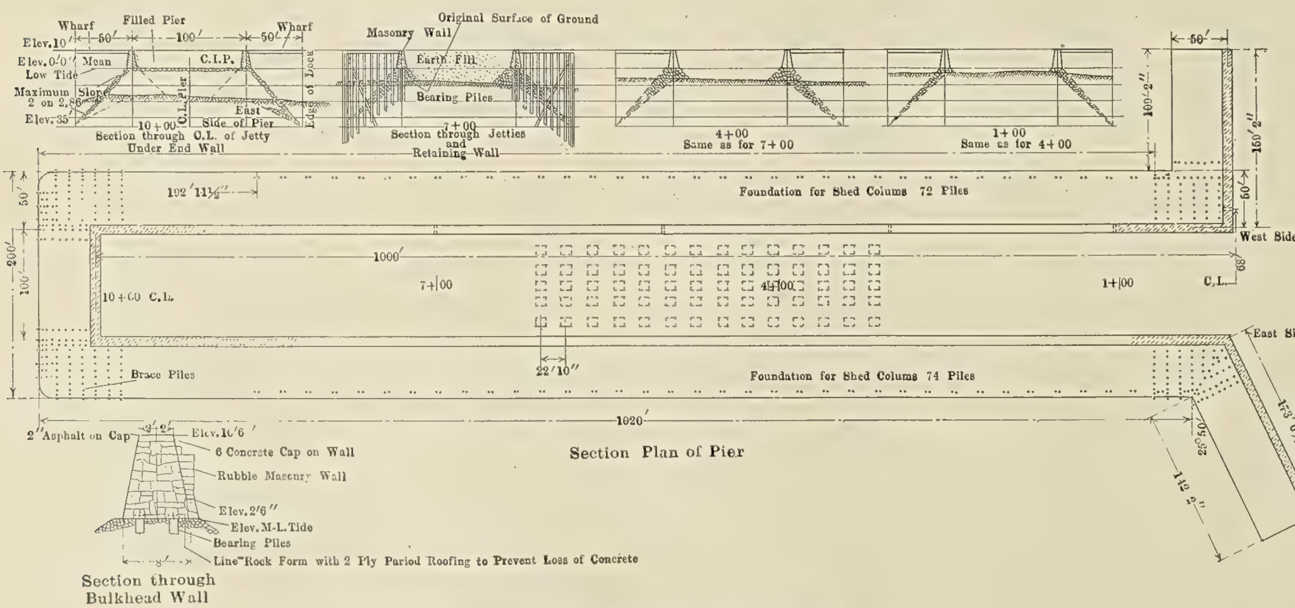


Fig. 3.—General Plan of the New Dock

ing surface for piers than concrete, which is apt to become wet and sloppy, and is complained of by workmen as being cold and disagreeable under foot.

To provide a yielding cushion for the contact of ships at the edge of the pier, the outer 6 feet is covered with 8-inch

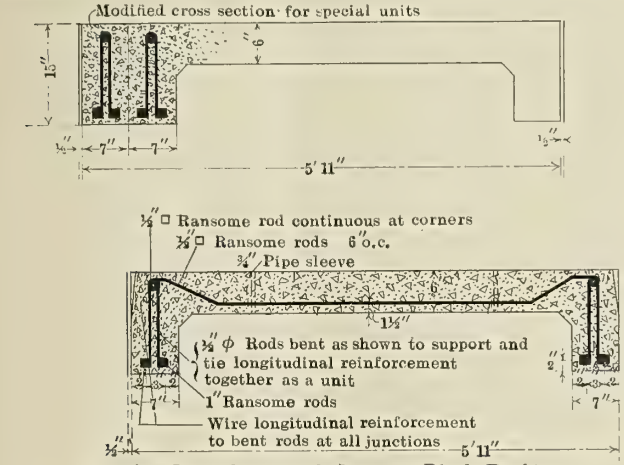


Fig. 4.—Cross Section of Concrete Block Decking

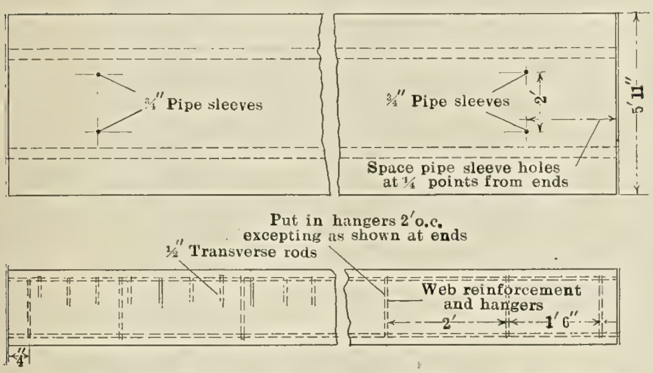


Fig. 5.—Longitudinal Section of Concrete Block. The Length Varies From 6 to 24 Feet

yellow pine planking and a system of oak fenders and bracing worked in along the outer edge. Arrangement has been made for double railroad track down the center of the pier in a depression, bringing the floor of the cars on a level with the deck of the pier and with provision for frequent bridging when cars are absent.

In working out this general design it was the intention to make the central portion of permanent construction, and eventually to build a fireproof warehouse upon part or the whole of the central part with large elevators and other approved appliances for handling package freight to and from ships. The pile construction of the pier on each side is considered to be only semi-permanent, and this attitude has been deliberately taken, as, after careful consideration, it was agreed that a permanent structure could easily have a structural life exceeding its commercial or useful life. An illustration showing the wisdom of this course is found in the case of a railroad bridge over the Thames River adjoining this property. The bridge is just twenty-five years old. It is in excellent condition and capable of use for many years to come, but it has outlived its commercial life, and at the present time plans are being made for the construction of a bridge to meet the present needs, which the old bridge will no longer fulfill. In the case of the new pier, it is considered that the creosoted piling, yellow pine clamps and braces and concrete block decking, which can be easily removed to replace a deteriorated pile or brace, will have a life of at least twenty-five years, which is considered to be the commercial life that should be considered for the arrangement and design of this pier.

Relative to placing a warehouse on the central portion of the pier for the storage of goods to and from ships, it is considered that this will in every way tend to rapidity of despatch in both receiving and delivering cargo, which is the first consideration in the arrangement of the connecting link between water and land transportation. This becomes a paramount consideration when it is clearly and fully understood that the financial return from transportation comes wholly or solely from moving the material from one place to another.

By referring to the plan of the harbor, Fig. 1, it will be seen that the general plans of the Harbor Commission contemplated two additional piers, and the bulkheading and creating of a considerable additional area of level land above the bridge from dredged material incidental to the dredging of a 35-foot channel for New London harbor. The manner of this general development of the harbor has been worked out in connection with the representatives of the United States Government, who have shown every desire to encourage and assist in the undertaking.

At the present time the contract for the pier up to the deck, including all foundations and the dredging of the slips on either side, has been let the T. A. Scott Company, of New London, Conn., and the work is being pushed as rapidly as possible.

Since the formation of the commission, Edward H. Warner, chairman, has resigned, and Thomas F. Noone, of Rockville, has been made chairman. The vacancy caused by the death of Oliver Gildersleeve has been filled by H. H. Hamilton, of Bridgeport. Valuable aid to the commission has been rendered by Governor Simeon E. Baldwin and Bryan F. Mahan, Mayor of New London.

Inclined Elevators for Economical Handling of Freight

In a recent lecture on the cost of handling freight at terminals, Secretary Redfield is quoted as making the statement that "It costs as much to load a barrel into a car at Chicago and to unload it at New York as it does to move the barrel

Fig. 1.—Inclined Elevator in Operation

between the two cities on the railroad." The railroad and the steamship lines are now face to face with this problem. The cost of handling freight by hand trucking, which is now almost universal at freight terminals, is out of all proportion to the charge by the transportation companies for carrying the freight. The cost of handling miscellaneous package freight is frequently 35 cents (1s. 5½d.) per ton at the terminal, and in some locations 70 cents (2s. 11d.) a ton would be nearer the amount.

A large proportion of the freight-handling charge is due

to the high cost and scarcity of labor available for this purpose. This is a condition that is not likely to improve, as it is becoming more and more difficult to find men suitable for this work. It therefore becomes necessary to devise some plan which will make it possible to do the laborious part of the handling by mechanical means and use the men to supply the needed intelligence to transfer a package of freight from one location to another.

The ordinary two-wheel hand truck, which can be placed under the package, bale, barrel or box with the least amount of labor, has been found, generally speaking, most satisfactory within certain limits. When it is necessary, however, to transport a loaded truck up an incline or for a considerable distance on a level, the man and the truck become inefficient and expensive.

The machines illustrated, known as inclined elevators, have been designed to eliminate the laborious part of manual trucking in handling miscellaneous freight, and in some cases where they have been installed the speed of freight handling has been accelerated 20 percent.

The unloading of freight from a ship requires the employment of a large number of men, and any apparatus which will produce more rapid movement or acceleration will show a corresponding saving in dollars and cents. This saving in some cases where these machines have been installed has amounted to a sum equivalent to the entire cost of the inclined elevators every sixty days of operation. The first cost of the apparatus is reasonable and the mechanism is simple and reliable.

Fig. 2 shows an installation at the Mystic Dock of the Boston & Maine Railroad at East Boston, Mass., where loaded trucks are carried up or down and empty trucks carried down or up simultaneously. The success of this installation has led to an order for two more similar equipments on the same dock. Equipments of one, two and three machines each have been installed on the Metropolitan Steamship Company's dock at Boston; the Merchants & Miners' Transportation Company's dock at Savannah, Ga.; the Old Dominion Steamship Company's dock in New York; at the Pequonnock dock of the New York, New Haven & Hartford Railroad at Bridgeport, Conn., and at other locations.

The double-deck pier shown in Fig. 2 is a further adaptation of this method of carrying freight trucks from one elevation to another on the continuous principle, both up and down. Double-deck piers are coming more and more into use, and it is being recognized that in addition to the very great saving in the cost of the ground area they have a valuable economy in the handling and storing of freight. It can be readily understood that a two-storied pier as a freight storage proposition is twice as compact as an equal floor area would be if spread over one surface; that is to say, the distance from a central point to all other points on the two floors would be approximately one-half the distance of a central point from all other points when taken on a single floor.

The chief objection to a two-storied pier lies in the fact that half the freight needs to be carried up and down between the two floors. This objection, however, has been practically eliminated by the use of the continuous-working inclined elevator, which has a very large capacity as compared with ordinary elevators, and, furthermore, is safe in operation and very economical as to power consumed. A two-storied pier has an important advantage, in that it permits packages of freight, which usually remain in storage for several days or a week at a time, to be transferred to the upper floor on the inclined elevators, leaving the floor below available for the freight which needs to be carted away more rapidly.

The inclined elevators shown are manufactured by the Otis Elevator Company, Eleventh avenue and Twenty-sixth street, New York, N. Y.

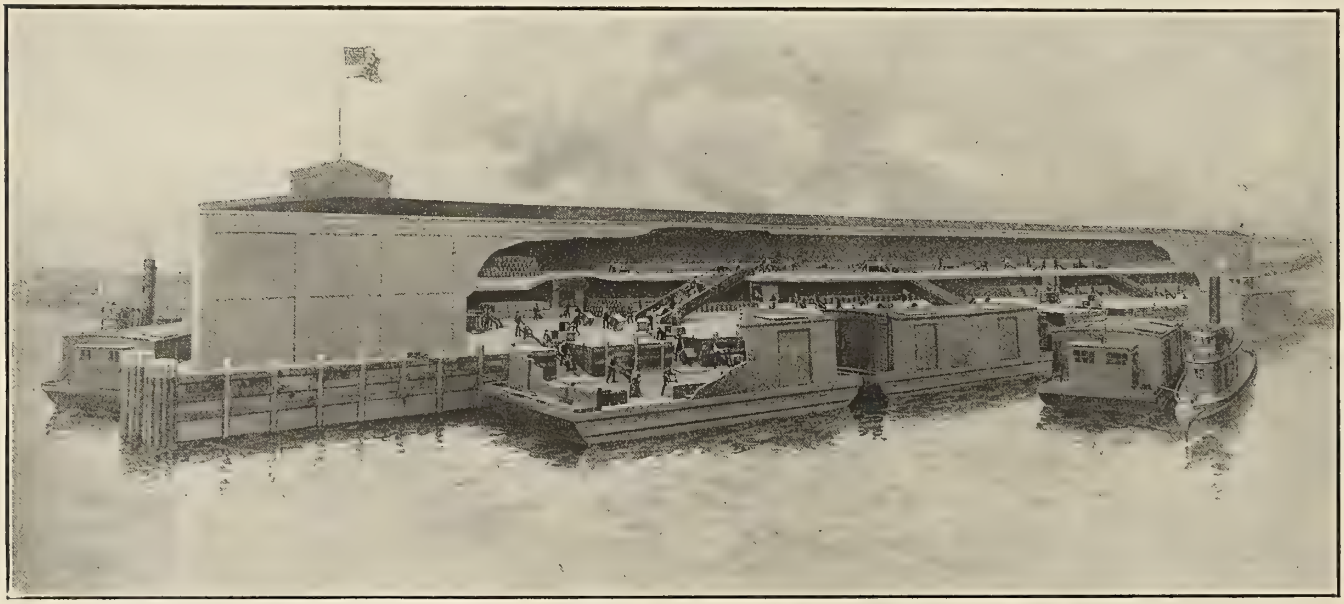


Fig. 2.—Installation of Inclined Elevators at the Mystic Dock of the Boston & Maine R. R. at East Boston, Mass.

The Economical Handling of Package Freight and General Cargo on Steamship Docks

BY C. A. HARDY

The handling of commodities from steamship docks naturally divides itself into two classes. In the first class is general cargo, consisting of miscellaneous ship package freight, in which the packages naturally vary in size and weight from the largest to the smallest. The other class consists of those commodities which, on account of the volume of traffic, can be loaded in solid cargoes.

Wherever the volume of this traffic has justified, special machinery has been designed and placed in service, which has effected large economies in handling. The most marked instances of successful work along these lines are found in the ore and grain handling on the Great Lakes. There has been considerable development in other lines, which have been mentioned from time to time in this journal; but such de-

velopments are beyond the scope of this discussion, as special machinery and docks are required in each particular case.

The great volume of freight handled at ocean terminals is included in the first class, and consists of miscellaneous freight, and for the economical handling of this freight but little has been accomplished. The packages vary so in size and weight that the equipment designed to handle the heaviest articles cannot be operated economically on the lighter packages.

Early Methods of Handling Freight

The general system in vogue has continued many of the crude systems of earlier days. When steamship service first came into effect all that was necessary was a plank dock wide enough for teams to drive out to the end and load and unload freight. Many of the modern docks continue this exact procedure. The ships were equipped with cranes of moderate capacity, which were operated by steam donkey engines, by which freight can be taken from the docks, deposited in the hold and loaded in the regular manner. Equipment of this kind suffices where only few cargoes are to be handled.

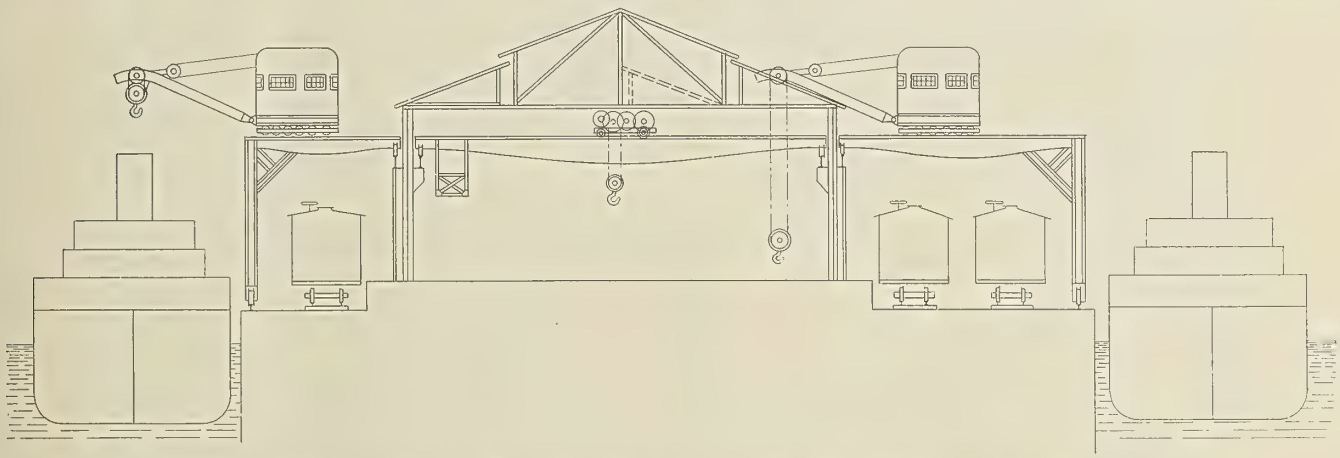
The next development, when the volume of freight increased, was to roof the dock over and use it as a storehouse, accumulating freight pending the arrival of a ship for reshipment and holding freight unloaded from the ship to suit the convenience of the consignee; in fact, using the dock as a freight warehouse.

These methods have served until the time has now arrived when the dock facilities at many important ports are overtaxed by the volume of freight to be handled. From an engineering standpoint the great difficulty of adapting modern crane service to the proper handling of freight arises from the fact that it is necessary for the crane to deliver freight at the hatchway of the ship and take it therefrom; this being approximately a point from 25 to 40 feet distant from the face of the dock. Consequently, swinging jib cranes mounted on a gantry framework have been developed on the Continent, and are in use at Hamburg, Liverpool, Manchester and elsewhere which are designed for this service. They can be constructed of sufficient capacity to handle all classes of freight at the proper speed. They can be arranged to operate either by steam or electricity, as desired. They can deliver freight readily at a point some distance from the dock side on the platforms of the warehouse, or in gondola cars or box-cars with sliding roofs, as used on the Tehuantepec Railway.

In order, however, to obtain the full economical benefit in service of this type of crane, the dock warehouse should be so designed that packages can be deposited by these cranes inside the building under the runway of another crane, and then picked up by a standard electric crane and taken to some designated point for storage or carried to the end of the building and set on drays or a lading platform as desired.

In order to properly supplement this service the dock should be laid with good concrete floors and electric truck service provided for handling small-package freight.

Trials have been made of the tram-rail systems, both electrically-operated and hand-operated, for handling this package freight; but owing to the fact that a roadway must be kept clear under the tram-rail for hand operators, and the fact that the hook can only handle packages stored directly under the runway, the storage room is limited, and a multiplicity of runways, switches, cross-overs, transfer cranes and complicated electrical equipment is required in order to fully utilize the storage space in the building, and consequently the tram-rail system is not as well adapted to the economical use of the space and the rapid handling of packages as a combination of the overhead crane and the electric truck.



Arrangement of Overhead and Traveling Cranes for Handling Miscellaneous Freight at Steamship Piers

Combination of Overhead Cranes and Electric Trucks

The sketch on this page shows an arrangement of dock combining these various features. Several sections in the roof of the dock warehouse are mounted on rollers, thereby allowing them to be swung to one side to allow the swinging jib cranes to take freight from the ship and lay it on the floor inside the warehouse under cover, where the traveling crane can pick it up and store it or pick up loads from the house and drop them into the hold of the ship. With this arrangement of traveling crane it is not necessary for teams to drive onto the dock proper. The cranes can over-run the team platform, pick up freight directly from the drays and also from the loading platform, carrying freight along the full length of the dock and deposit it at the proper point. By this arrangement the necessity of maintaining a clear roadway for teams the entire length of the dock is obviated.

With electric trucks package freight can be carried and properly distributed on the dock very quickly and much cheaper than with hand trucking. This relieves the overhead crane from the troublesome handling of small packages.

From investigations of the various methods of handling freight in freight warehouses, especially by the tram-rail system at St. Louis, the electric truck system on the Burlington Railway, the hand-trucking in various railway freight terminals, and package freight on the New York and San Francisco docks, cotton handling at New Orleans and Galveston, it seems certain that wherever the volume of freight is sufficient to justify the expense a material saving in handling miscellaneous package freight can be effected as outlined in this article.

Fig. 1.—One-Leg Gantries in the Harbor of Hamburg on the Day of Opening

Electric Gantry Cranes for Terminals

Construction and Principal Features of the Electric Gantry Crane Widely Adopted for Handling Freight at Steamship Terminals—Tests and Costs of Operation

BY F. W. BUSE

It has been most interesting to note the extended movement toward the improvement of existing harbors and the development of new ports in the United States during the past few years. Various large cities have found it necessary to pay more attention to the development of their port facilities in order to retain their share of the shipping trade which might otherwise be secured by rival communities with improved facilities. The cost of handling and transferring the freight and the time which is required to load and unload a vessel are decisive factors for a steamship line in the selection of a harbor; it is therefore necessary for the harbor commissioners to give the selection of the loading appliances their utmost attention.

Just as it is impossible to have a standard layout from which a harbor can be built, the type and size of loading and unloading appliances cannot be determined without taking into consideration local conditions, the amount and class of freight to be handled, and the kind and size of the ships, etc.

Extensive Use of the Electric Gantry Crane

While unloading cranes and plants for coal and ore have been highly developed in the United States, it must be said that little attention has been paid to unloading devices for the regular package freight. Cranes for the handling of this class of freight have been developed, however, to a high degree of efficiency in Europe, and the electric gantry crane has been adopted as the most satisfactory means by all the large sea and inland harbors in Europe. In the ports of Hamburg, Bremen, Antwerp, Rotterdam, London, Liverpool, Havre, Marseilles, Genoa, Triest, Stockholm, etc., these cranes are used extensively. In the harbor of Hamburg alone over 400 electric gantry cranes are in daily service.

It seems reasonable to assume that the electric gantry crane will be adopted as the standard appliance for the loading and unloading of ships in the United States also. The ship's winch may be satisfactory where the goods have to be deposited close to the hull of the boat, but in modern harbors,

Fig. 2.——One-Leg Gantries with Luffing Gear in the Harbor of Hamburg

where railroad tracks are arranged between the quay wall and the warehouses, and where the goods are loaded either into the cars or into the warehouses, or vice versa, the gantry crane offers the best solution of this problem. With its long jib it can not only cover a considerable horizontal distance but it can also reach a considerable height, and can deposit goods even into the second story of modern warehouses, laying them down on platforms in front of the doors, whence they are distributed in the inside of the warehouse by monorail trolleys or similar means.

change the outreach of the hook according to the beam of the steamer, especially if large quantities of goods have to be loaded through the same hatch.

The gantry can be built to span either one or more railroad tracks along the quay wall; the height is chosen according to local conditions. If the gantry travels by means of electric power, this movement is also controlled from the driver's cab. In case the gantry is moved along by hand power this is done through removable cranks turned by one or more men, according to the size of the crane.

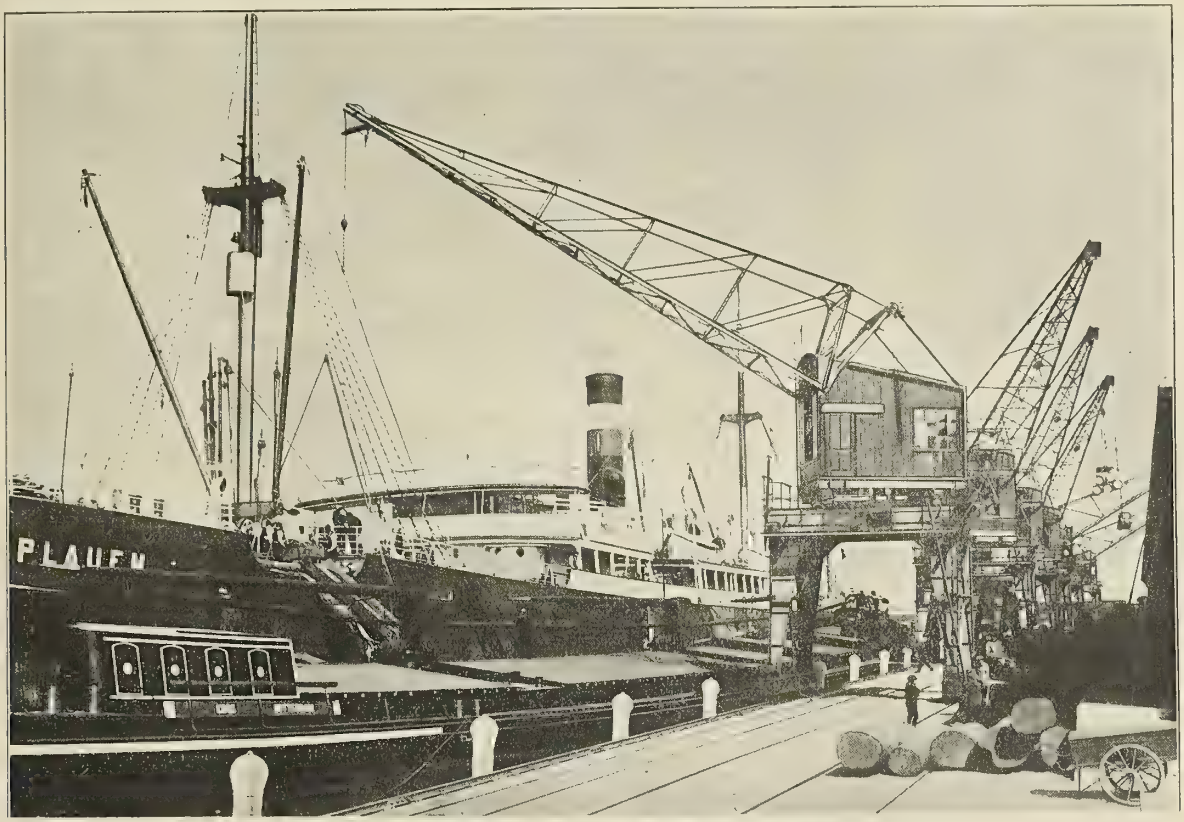


Fig. 3.—Two-Leg Gantries with Luffing Gear in the Harbor of Amsterdam

The purpose of these lines is to set forth the construction and the principal features of the electric gantry crane.

CONSTRUCTION

As will be seen from the illustrations the crane consists essentially of a one or two-legged gantry and a revolving jib crane on top of same. The gantry is moved either electrically or by hand. The hoisting and revolving appliances are driven by separate motors, and are arranged in the driver's cab, which is completely enclosed. The operator has his stand in the forepart of the cab, where large windows afford him a good view of the working field and protect him from the weather. The controlling apparatus is so constructed and arranged that an inexperienced man can handle the crane safely and with the least amount of manual work, so that he can give his entire attention to the movement of the load. The hoisting gearing can be built for work with an ordinary hook, or with a grab-bucket, self-dumping bucket, magnet or any other special lifting device.

In many cases the jib is made movable to give the hook a different reach from the center of the crane, as shown in Figs. 1, 2 and 3. If this is done the jib is luffed in and out by means of screws operated by the driver in the cab, either by hand or by power. Sometimes this is done for the purpose of lifting heavier loads at a smaller outreach without increasing the tilting moment of the crane, at other times it is desirable to

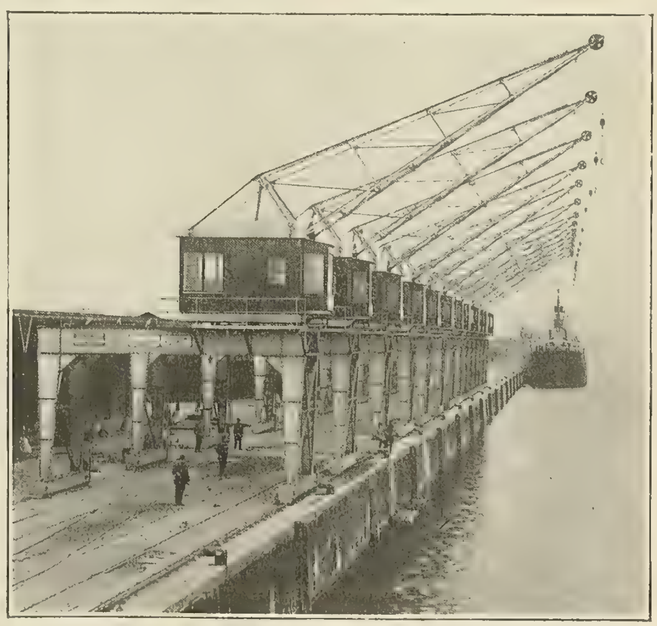


Fig. 4.—Two-Leg Gantries Spanning Several Tracks in the Harbor of Ghent

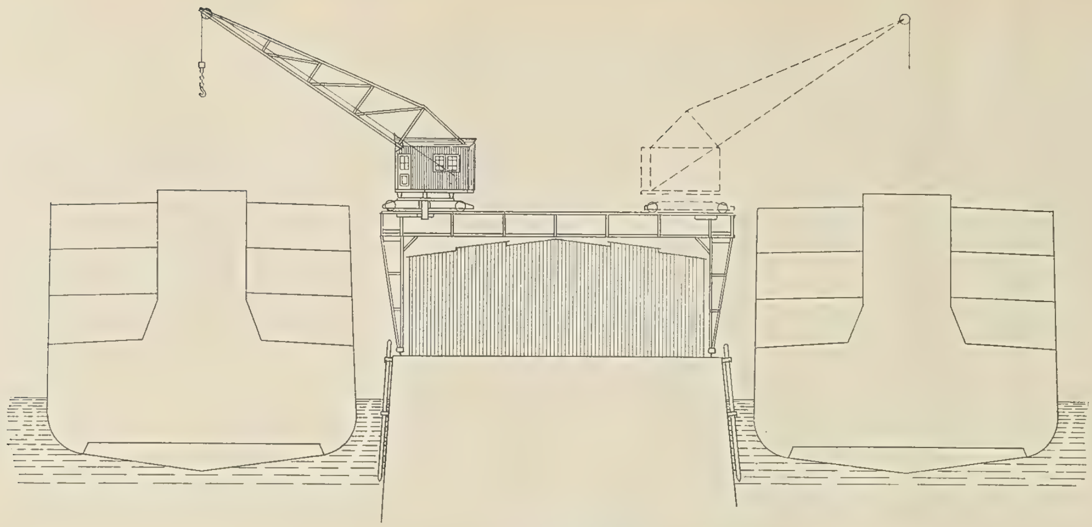


Fig. 5.—Application of Gantry Crane for Projecting Piers

Capacity and Arrangement

Cranes for unloading package freight usually have a lifting capacity of 1.75 to 5.5 tons and a radius of about 40 feet, whereas the capacity of cranes for loading coal is not below 5 tons, and for unloading ore even more. As for the electric current, this can be either direct, alternating or single-phase up to 600 volts. The current is supplied to the crane by a flexible cable or by feed lines arranged below or above the floor in the usual manner. The general arrangement of the cranes on the pier can be seen from Figs. 1, 2, 3 and 4.

That the gantry cranes can be used to advantage on projecting piers is shown by Figs. 5 and 6. In Fig. 5 the gantry spans the entire building, and is running on two rails on the floor of the pier. The crane itself travels on the top of the gantry, and can serve ships on both sides of the pier. The goods can be brought into or out of the warehouse, either through the doors or through hatches in the roof. The hatches can be made as large as necessary, and can extend over the entire length of the roof. They can be shut by sliding covers, which might be operated by the crane. Where it is not advisable to have hatches in the roof the warehouse should be narrower, to allow more space between the warehouse and the gantry leg to provide for a platform on which the loads are deposited.

The arrangement in Fig. 6 provides for two cranes on the roof of the warehouse, working in the same way as described before. Instead of having two bridges, one bridge spanning the entire width of the roof may be arranged, on which one crane would work similar to the one in Fig. 5. In the latter case, the columns supporting the warehouse must be considerably heavier than those in Fig. 5. The advantage of the arrangement in Fig. 5 is that it can be used on existing warehouses.

Loading Capacity and Current Consumption

Thirteen one-leg gantry cranes, which went through severe official tests and which were put into service only a few months ago, represent a good example of the loading capacity and the current consumption of a standard electric gantry crane. The cranes, which are similar to the ones shown in Fig. 2, have a maximum lifting capacity of 5.5 tons of 2,000 pounds. They are equipped with an electric-driven luffing gear, so that the radius can be varied between 52.8 and 36.4 feet. The horizontal distance between the two rails on which the one-leg gantry travels is 41.7 feet, the vertical distance between the top of the rails 28 feet. In the lowest position of the jib the top sheave is 70 feet above the lower rail. All the motions of the cranes, *i. e.*, hoisting, revolving, luffing and the traveling of the gantry, are electrically driven through separate direct-current motors of 550 volts. The hoisting gearing is provided with shift gears, so that loads of 1.75 tons can be lifted at a speed of 230 feet per minute, and loads of 5.5 tons at 80 feet per minute. A full revolution with the maximum load at the greatest outreach can be made in half a minute. Smaller loads can be handled at an increased speed according to the increase of

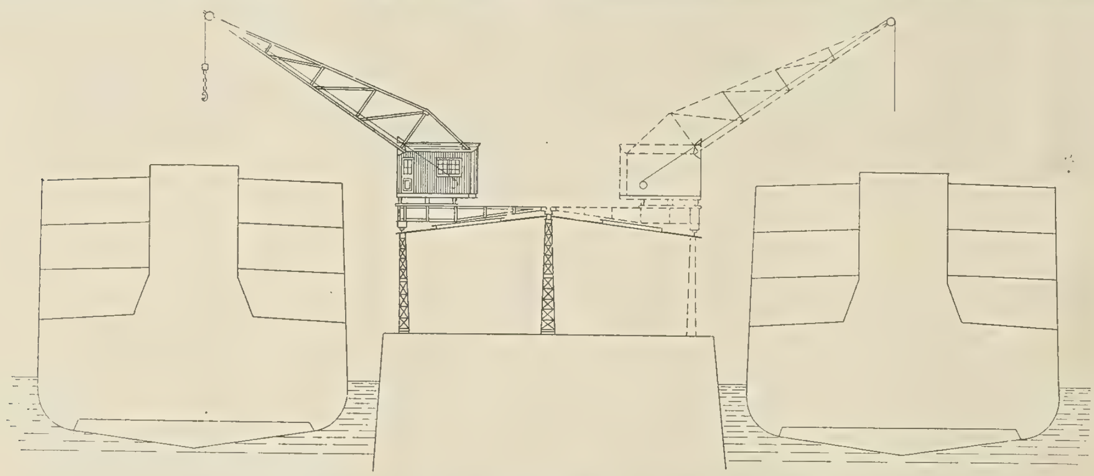


Fig. 6.——Application of Roof Crane for Projecting Piers

revolutions of the direct-current motor at decreased load. The current is supplied to the cranes through a flexible cable, one end of which is fastened to a self-feeding drum at the gantry leg, whereas the other end can be connected to plugs arranged on the floor along the quay. The tests were made for the following cycle:

Lifting the load 29.5 feet.
Revolving with load through an arc of 120 degrees.
Lowering the load 10 feet.
Depositing the load (5 seconds).
Lifting the empty hook 10 feet.
Revolving back 120 degrees.
Lowering the empty hook 29.5 feet.
Attaching the load (5 seconds).

Results with a load of 5.5 tons on hook:
Time required for one cycle, 65 seconds.
Current consumption per ton of load, 50 watts.
Loading per hour 300 tons of 2,000 pounds.

Results with a load of 1.75 tons on hook:
Time required for one cycle, 50 seconds.
Current consumption per ton, 70 watts.
Loading per hour 125 tons of 2,000 pounds.

Assuming that the cost of current is 3 cents (0/1½) per kilowatt, the cost of current for loading *one ton* would be .15 cent when handling 5.5-ton loads, .21 cent when handling 1.75-ton loads.

COST OF OPERATION

When handling 1.75-ton loads during an eight-hour shift the capacity of the crane would be 1,000 tons and the current would cost $2.10 (8/9). For handling 5.5-ton loads the capacity would be 2,400 tons and the cost of current $3.60 (15/0). The current consumption was measured at the plug, and includes also the losses in the wiring.

While the above-mentioned loading capacities will naturally not be obtained in the regular service owing to the variation in the weight of the pieces, and unavoidable delays in handling same, the current consumption will not vary much from the figures given. A saving of time can be made by combining two different motions; *i. e.*, lifting and revolving, etc.

Like every other machine the crane shows the highest efficiency when working with the full load for which it is designed. It is decidedly advantageous to install cranes of a capacity with which they have to work the greater part of the time. If it should be necessary to lift heavy loads two cranes can be employed lifting simultaneously. In large harbors it has been found practicable to install some cranes of higher capacity besides a majority of cranes of the standard size.

Owing to the simplicity in construction and the strength of the cranes their handling and upkeep are simple and cheap. The life of one of these gantry cranes can be taken at about twenty-five years, but it naturally depends upon their handling. The expense for lubrication, cleaning and upkeep amounts to about $60 (12/10/0) per year for the first few years and increases slightly.

A calculation based on the above-named cranes shows that including the wages of the operator, current consumption, depreciation, interest and upkeep 1 ton of freight can be unloaded for about 1 cent (0/0½).

CONCLUSIONS

In summing up the contents of this brief article the following main features which recommend the use of the electric gantry crane, and which appear clearly in the illustrations, may be mentioned. Besides a comparatively low initial cost and upkeep the cranes have a large loading capacity and a high efficiency. The cost of operation is low, because only one man is needed for the handling of a crane, even under the severest conditions. They occupy small floor space, and no part projects permanently beyond the quay wall. The hook can easily be brought in and out between the masts, and the crane can work in any weather, as there are no parts employed which are affected by either heat or cold.

The illustrations show cranes built by the Deutsche Maschinenfabrik at Duisburg, Germany (also known as "Demag," and represented in the United States by Messrs. Neumeyer & Dimond, New York), who have been instrumental in the development of the electric gantry crane during the last fifteen years, and who have built many hundreds of these cranes, among which are the above-mentioned cranes.

Patent Barge for Coaling the Imperator and Other Large Hamburg American Steamships

BY F. C. COLEMAN

A patent barge, intended for the coaling of the *Imperator* and other large vessels of the Hamburg American Line, has recently been built by the Antwerp Engineering Company, of Hoboken, Belgium. This craft consists primarily of a large pontoon-like vessel, upon which is mounted a superstructure, the height of which varies from 32 feet to 60 feet above the waterline to the underside of the tower platform.

The vessel, built to the highest coasting class of the German Lloyds, has the boiler and machinery aft, and the crew space, etc., forward, the 'midship part being divided by bulkheads into sixteen compartments. The bottom of these compartments is not fixed, but consists of a hinged door each side of the center. These doors are raised at the outside edge to an angle of about 45 degrees by a pair of hydraulic rams, causing the coal to fall to the center line, when so much of the coal has been taken out of the compartment that it will no longer run at the bottom of each compartment. At the center line are three hoppers closed by sliding doors worked by a weigh shaft running the whole length of the coal compartments, to which each door is coupled separately by pneumatic clutches, controlled from the deck.

Along the center line of the ship between the center girders up the forward leg through the tower top and down the after leg, forming an endless chain, runs a series of buckets, each containing about 3 cwt. of coal. On their journey through the tower the buckets are upset by a dumping apparatus, the coal falling into fixed shoots, and thence into cylindrical telescopic shoots having a universal joint at the underside of the tower platform to enable them to hang in any direction into the bunker hatches or side ports. By a special arrangement of the hoppers the coal can fall only into the buckets, instead of, as in previous designs, the bucket chain having to be virtually dragged through the mass of coal which is pressed on the buckets as soon as the hopper doors were open.

To prevent large lumps of coal falling into the buckets or blocking the hoppers, revolving pricker knives are fitted, worked from shafting running the whole length, and each set connected independently by pneumatic clutches controlled from the deck.

An ingenious arrangement is fitted to control the admission of the water to the hydraulic rams to ensure the bottom doors lifting evenly, while another device prevents the buckets from becoming over-filled. The elevator chain is actuated by an 80-horsepower steam engine, the steam being supplied from a 100-square foot heating surface Cochran boiler. Electric and pull signal bells and electric lights are fitted throughout.

Suspended from the underside of the tower is a grab runway derrick crane, with a luffable jib about 50 feet long, working a 2-ton grab and loading coal into the barge at the rate of 180 tons per hour. This grab derrick is worked by a 165-horsepower motor from a 200-horsepower, direct-coupled condensing engine and dynamo, and fitted throughout with the

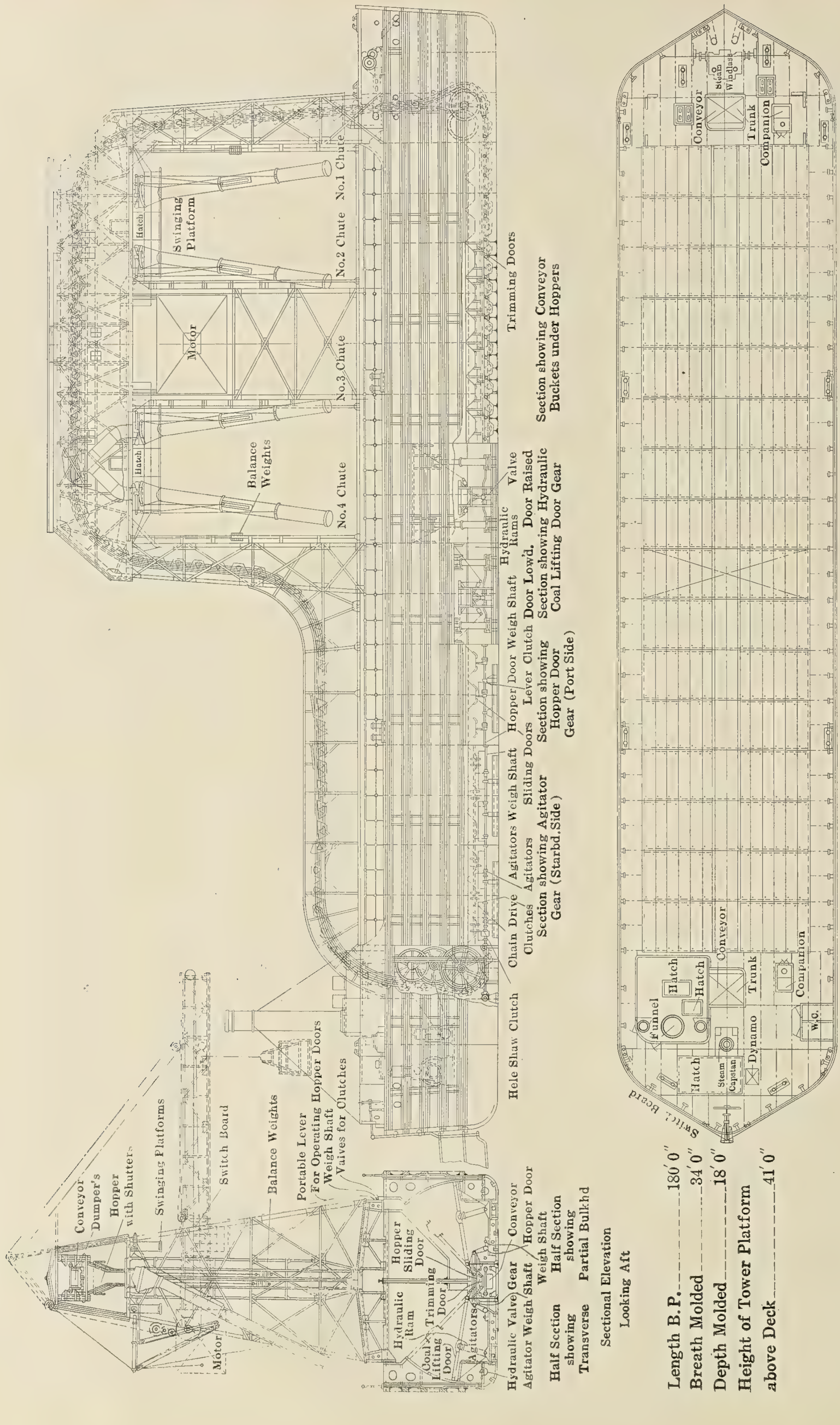


Fig. 1.—Section, Profile and Plan of Patent Coaling Barge for Hamburg American Line Vessels

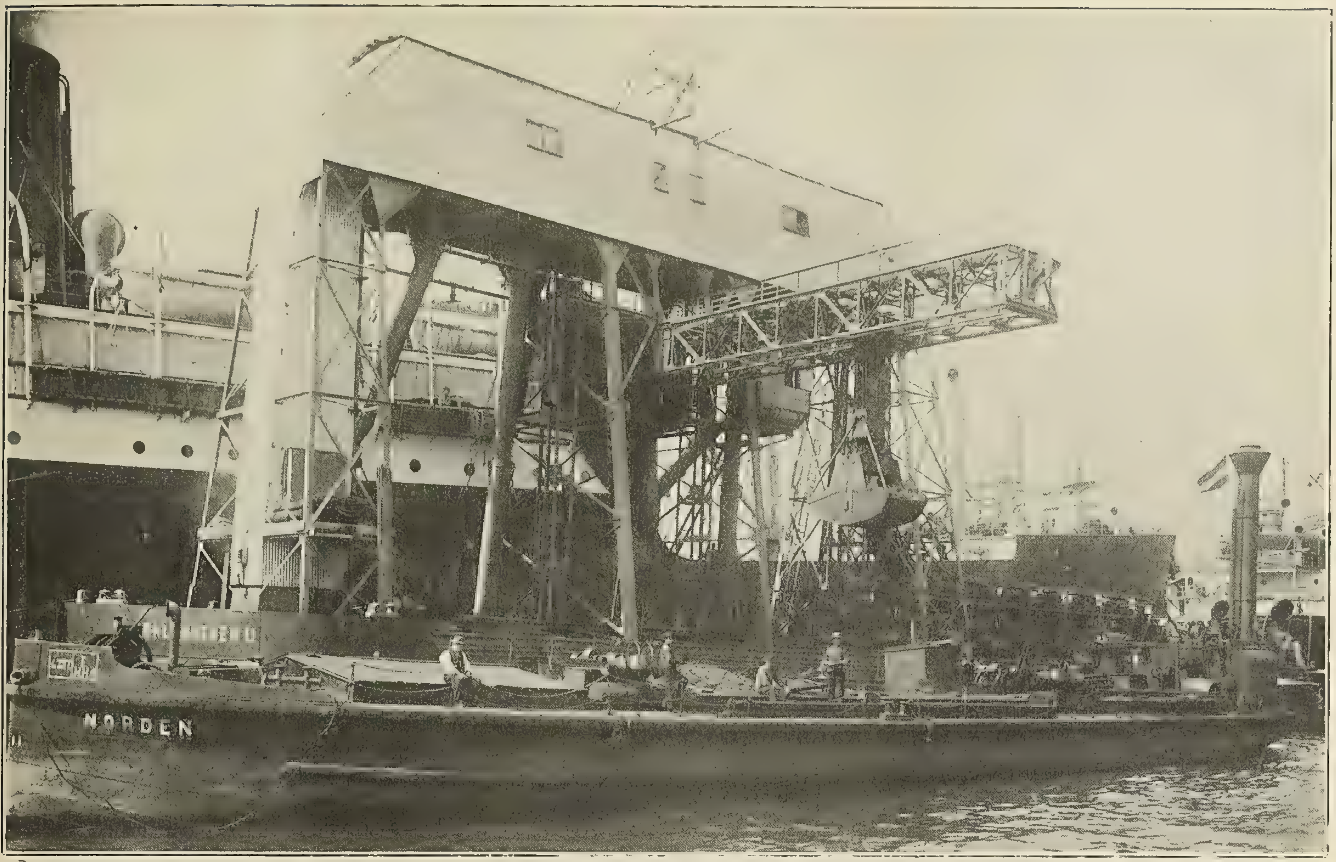


Fig. 2.—Patent Coaling Barge in Operation

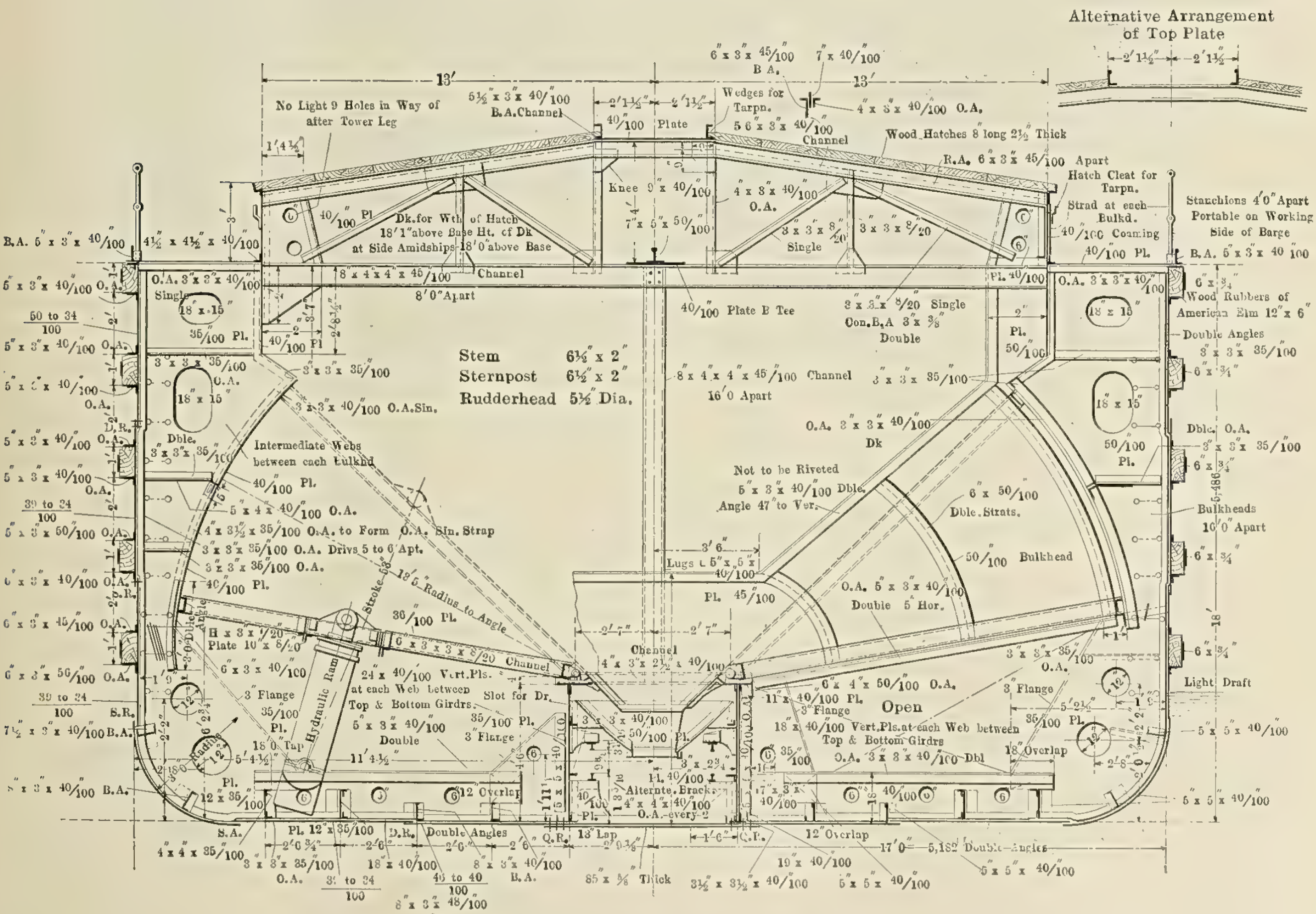


Fig. 3.—Midship Section of Coaling Barge

Leonard system of control, whereby all of the motions of the grab, lifting, lowering, running in and out, and the opening and closing of the grab are actuated by a single lever.

The present barge discharged on trial over 250 tons per hour, at the same time taking on board 180 tons per hour with the grab from coal barges alongside. The coaling barge loads in itself 1,250 tons of coal, so that, when discharging 250 tons per hour, and leading into itself 180 tons per hour, it is possible to work into bunkers nearly 18 hours, or 4,500 tons of coal, without refilling at the tips.

The Overhead Wharf Crane

BY HARRY SAWYER *

Until recently the problem of rapid and economical handling of miscellaneous package freight has received but scant attention in America. While the quays and piers in important foreign ports have been equipped with cranes for general cargo, the equipment at our own ports has been confined almost exclusively to means for handling uniform cargo, usually bulk material such as coal, ore and grain. But improvement in this condition seems assured. With the very general awakening to the necessity for more and better port facilities, so noticeable in the past two or three years, has come a realization that mechanical appliances must be installed, and, in most of the port development work now under construction or projected, some form of miscellaneous freight-handling apparatus is contemplated.

The problem of freight handling at a marine terminal naturally divides itself into two parts: the loading and unloading of ships and the handling of the freight on the pier. Close relation of the two is important, but it is the purpose at this time to discuss only the former.

It is not likely that any of the European types of wharf cranes will be found satisfactory and will be adopted for our American ports. A new type that will meet the most rigid requirements of speed, safety and economy is illustrated in the accompanying cuts. This crane is a radical departure from foreign practice in several essential respects, as indicated below:

It travels on elevated tracks above the roof of the shed, leaving the floor unobstructed.

It carries freight to and takes it from a point well within the shed, where it is protected from the weather.

It carries freight between the ship and the shed in a straight line at right angles to the edge of the pier, which is the shortest course.

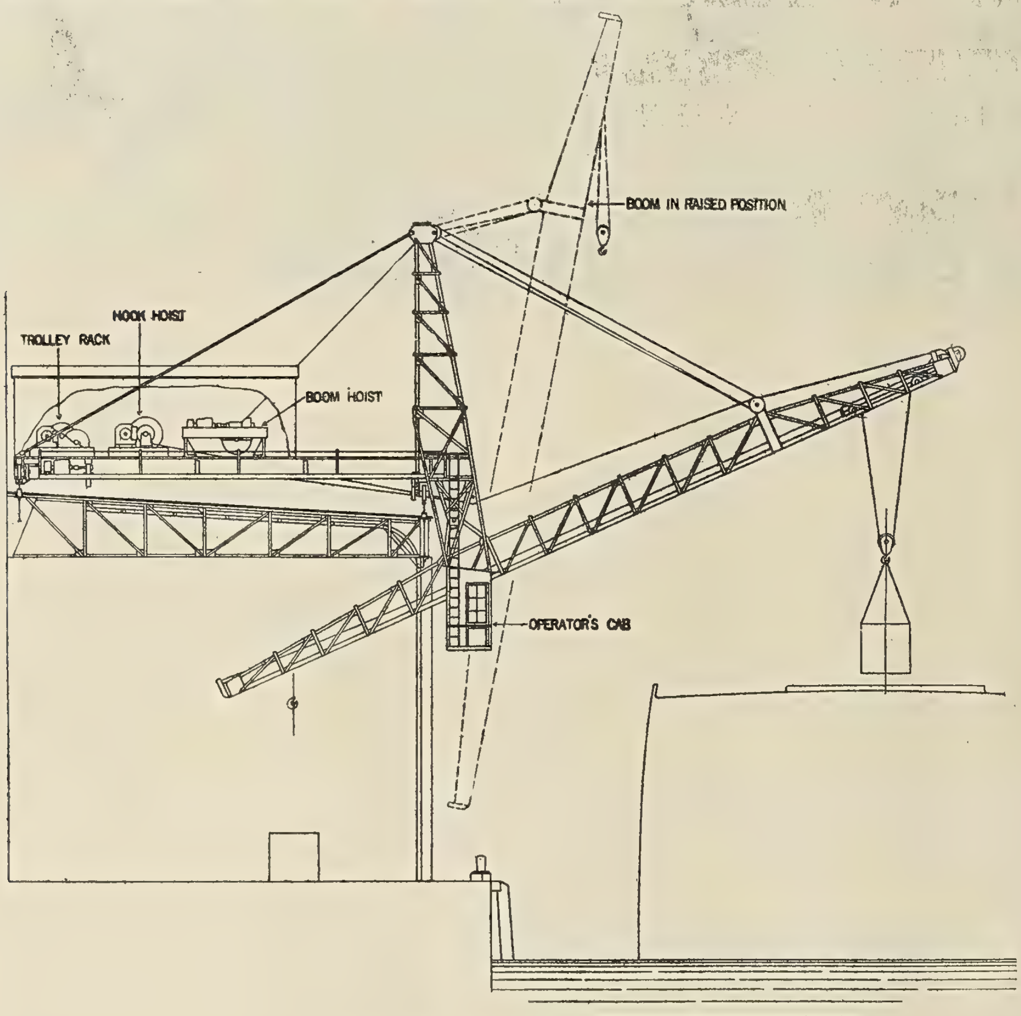


Fig. 1.—Shaw Overhead Wharf Crane

Freight is handled more safely and with less loss by breakage, because swaying of the load is, to a great extent, avoided and more perfect control secured.

To those responsible for the construction and equipment of piers it must be apparent that the pier deck area is too expensive and too valuable to be used unnecessarily for crane tracks and crane structure. No manufacturer would for a moment think of equipping his shop with cranes of the gantry type running on tracks at floor level, and there is even more reason for mounting wharf cranes on elevated tracks, for, at a busy marine terminal, congestion is often greater and space more valuable than on the shop floor. The advantages of

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reaching inside the shed with the crane are obvious. The freight is placed under the roof and where it can most conveniently be sorted and checked.

The direct or straight line travel between ship and shed is in every way better than the circular course of the swinging crane mounted on the portal or semi-portal base so common abroad. The direct course is shorter, quicker and cheaper. There is less tendency of the load to sway, because of the straight line movement and because it is suspended on a much shorter length of rope as it approaches the place where it is to be landed on the shed floor.

In the swinging crane a large mass of machinery, including hoisting and slewing mechanism, frame, boom and, in fact, all rotating parts, must be started and stopped for every horizontal movement of the load or empty hook. In constantly overcoming the inertia of this great weight there is unnecessary loss of time and power and increased machinery depreciation. The swinging or circular motion crane has long since given way to the straight line motion crane for industrial purposes, and the straight line motion is equally superior for wharf service.

The boom of the overhead crane when in working position stands with the outer end extending over the ship and the inner end projecting through the door into the shed. The usual working angle is 24 to 30 degrees from the horizontal; but this angle can be varied as the height of the boat and other conditions may require. A light trolley, from which the hoisting block hangs, travels out and in from one end of the boom to the other. When the crane is not in service the boom can be raised to a nearly vertical position, in which position the lower end is withdrawn from the shed and the upper end is removed from over the ship. The shed doors can then be closed, the crane can be moved to another position, and the ships can sail or dock without interference with the crane boom.

The machinery for the various motions, hook hoist, boom hoist and trolley rack is placed well back on the supporting frame, where it acts as a counterweight, giving stability to the crane. The cab, from which all movements are controlled, is suspended in a position to give the operator the best view of the load.

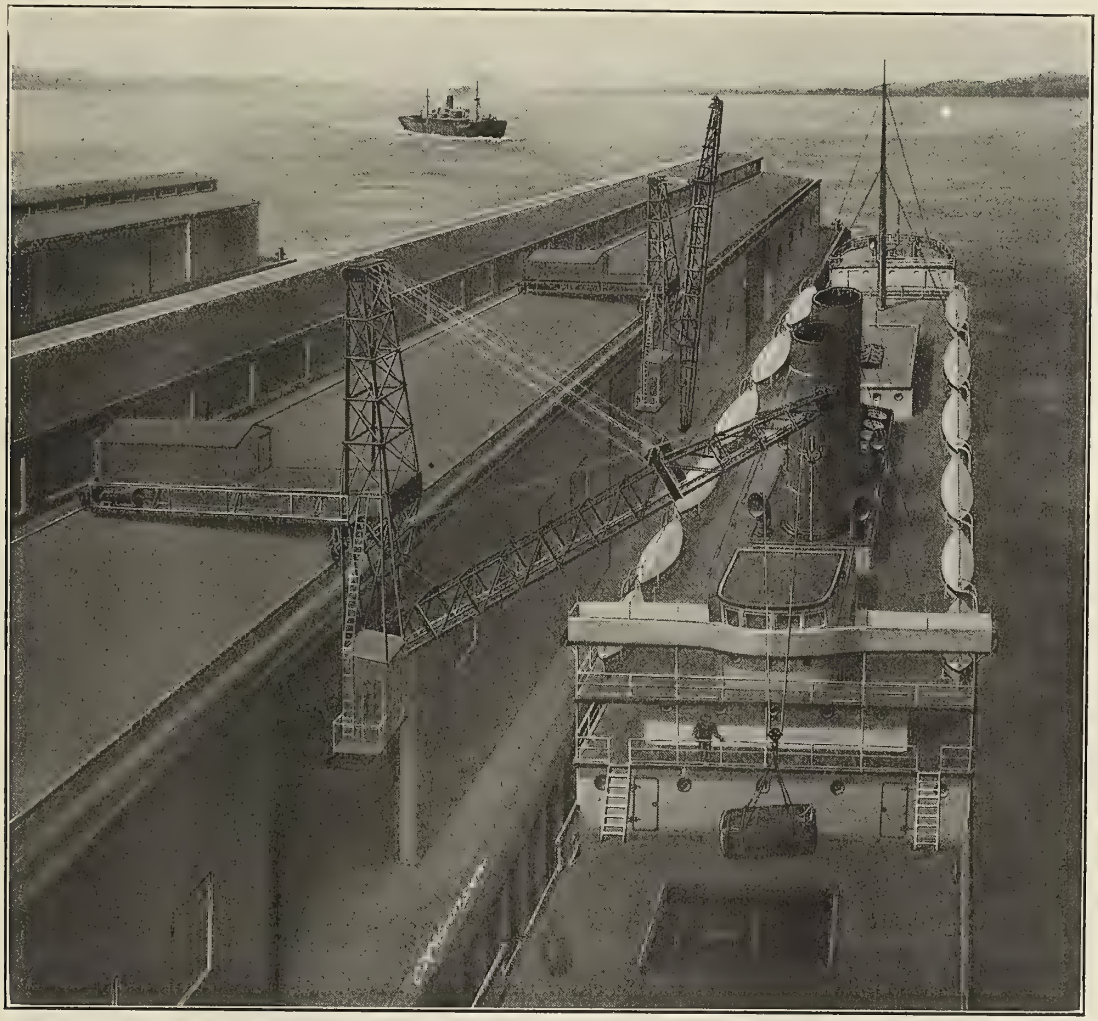


Fig. 2.—Adaptation of Overhead Wharf Crane to Ordinary Steamship Pier

The overhead wharf crane is particularly well adapted to those terminals in which a railroad track is extended along the edge of the pier. Having no supports outside of the railroad track the space is entirely clear, so that long material, such as poles, railroad rails and structural steel, can be handled between ships and cars without swiveling.

This type of crane can be built to operate on tracks carried over the roof of a two-story freight shed, and serve both the first and second floor. To meet this condition the boom is carried on a vertically adjustable member. The shift from one floor level to the other must, of course, be made with the boom in the vertical position. The reeving of ropes is such that the position of the lower block relative to the trolley, the position of the trolley on the boom, and the angularity of the boom are not affected by the vertical adjustment.

For piers on which the shed is placed so far back that it is not practical to reach the ship from overhead tracks, a crane

is recommended having the same boom and operating machinery, but traveling on one elevated track carried by the building columns and one surface track at the edge of the pier. Such a crane gives the same advantages of direct and rapid handling but not the unobstructed pier.

A capacity for handling loads up to 6,000 pounds is considered sufficient for most terminals, but this, as well as the reach, span and other dimensions, can be varied to meet local requirements. The crane shown, having an effective reach of 40 feet beyond the edge of the pier, is stable with more than double its normal load in the extreme position, but to make tipping impossible under any conditions hooks are provided, projecting under the flanges of the rear runway.

A comparison of costs, it is claimed, shows that freight is handled as cheaply at our ports with a combination of ship and shore winches as in European ports with wharf cranes. This seems not at all impossible when we consider the type of cranes there used, and the course of our port commissioners in not installing general cargo cranes in the past may be justified; but the comparison must not be accepted as proof that no crane installation can be made that will be faster and cheaper than our present methods. A very considerable saving should result from the use of the overhead crane as compared with other types of cranes or the ship's tackle and stationary winches, on account of the greater practicable speeds, the shorter course traveled by the hook, and the fact that one man controls all movements.

A factor of importance is the reduced damage to freight from rough handling. Swaying is unavoidable when a load is suspended by long ropes from the end of a swinging boom, and is sometimes resorted to, in connection with the use of ship's tackle, as a means of throwing a sling load of freight inside the shed. The perfect control and absence of serious sway avoid the principal causes of damage to freight handled by other means.

The demand for greater economy and dispatch is imperative. Apparatus that will reduce the time a ship must remain at the pier, reduce the labor cost, reduce the damage to freight and increase the capacity of the pier, will go far toward solving the marine terminal problem.

Concrete Docks versus Wooden Docks

American Dock Engineers Following the Lead of Their European Contemporaries in the Adoption of Concrete Docks

BY HARRISON S. TAFT

With the vast harbor developments being made at nearly all of the Pacific Coast ports in the United States, preparatory to the opening of the Panama Canal, the question of a suitable type of dock construction is occupying a prominent position in the minds of Pacific Coast dock engineers. In San Francisco Bay and other California ports the dock engineers have developed a special type of concrete dock, consisting of concrete columns, concrete-encased steel or reinforced concrete beams and a concrete deck slab. Another type of construction consists of using wooden piles encased in a watertight concrete shell, with a suitable concrete deck beam and slab system. Still other California ports are developing a type of semi-concrete dock, viz.: concrete piles supporting a wooden deck structure. Since California is some 1,000 miles distant from the lumber supply of Puget Sound forests, her ports would naturally precede those located on Puget Sound in adopting concrete for dock construction.

Puget Sound being surrounded by a forested country it was only natural, with the rapid growth and expansion of that section of the country which followed the discovery of gold in Alaska in 1898, that wooden piles should have been extensively and exclusively used in the dock work of Puget Sound shipping ports. Up to the present time no attempt has been made in the way of using reinforced concrete in the dock work of either Seattle or Tacoma. The only location on Puget Sound where concrete docks exist is at the United States navy yard, Bremerton, Wash.; one being 60 feet by 402 feet, built in 1911, the other 80 feet by 490 feet, now under construction (1914). Farther to the north, at Vancouver, B. C., the Great Northern Railroad Company recently completed (1913) a quay type of reinforced concrete dock in connection with an extensive water-front terminal. This dock is the only commercial concrete dock on the Pacific Coast north of San Francisco.

In adopting concrete for marine structures a far different problem is met with than in the use of it in buildings or other dry-land structures. On the other hand, in using wooden piles for dock work the dock engineer has to contend against an equally different problem than in using wood in land structures. With wood the destructive sea borers have to be contended with and the damage they do provided against. In the use of cement in sea water the chemical action of the contents of salt water upon the properties of cement has to be studied and provided for. With either type the dock engineer has to sail his ship between the Scylla and the Charybdis of the problem, with the "rock of cost" standing out ahead of him.

Teredo the Enemy of Wooden Docks

Since the teredo will destroy a green wooden pile inside of eleven months in Puget Sound waters, in nine months in San Francisco Bay, with a record of six months in Alaska, the annual cost of replacing the fender pile system of these docks is a very serious problem. When it is considered that a creosoted-pile dock is good for about ten to twelve years in San Francisco Bay, and twelve to fifteen years in Puget Sound ports, the question of the continued rebuilding of wooden pile docks, and the cost of doing this every ten or fifteen years, are beginning to receive serious attention, not only on the part of Pacific Coast dock engineers but by the public in general.

In Atlantic coast ports, north of Cape Cod, the waters are so cold that they are uninhabitable by teredo, compared with those ports nearer the Gulf Stream. In Boston oak piles can be used with success even when they support a reinforced concrete deck structure. Thus semi-concrete docks can be successfully built and operated in the waters of Massachusetts Bay and vicinity, the wooden piles being cut off at mean high water with the rest of the deck structure built in reinforced concrete.

Along the water front of New York City and the Jersey shore, where sewage is destructive of teredo, the semi-type of construction, viz.: wooden piling and concrete decking, can be and is used extensively. Unless the piles are cut off at or below mean high tide—the lower the better—that part of the structure exposed to alternate wet and dry conditions is destined to rot away with the same speed as if the whole structure were of wood, since the part below low water will last as long in one case as in the other. Such a type of semi-

concrete dock, having the wooden piles cut off at low water, is far more preferable.

Farther down the Atlantic coast the teredo are so destructive of wooden structures standing in the sea water that some type of concrete piles becomes a necessity, if the rebuilding of the docks at the end of every ten years or so is to be avoided. In some of the Southern ports are found concrete pile, wooden-deck docks, full concrete docks of various designs, concrete encased wooden piles with a concrete deck beam and slab system, all depending upon the location and purpose to which the dock is to be put.

While concrete may be a long-enduring material in land structures, unless it is made of proper material, properly mixed, handled and cured, it would perhaps be far better not to use it in that part of dock structures standing in sea water carrying the main loads, viz.: the concrete columns or concrete piles. When made of suitable cement, suitable sand and stone or gravel, properly mixed and cured, there is no reason why concrete should not be made a lasting material for salt water structures, barring any serious damage due to collision, etc.

Selection of Materials of First Importance in Concrete Docks

In using concrete in dock work, not only is it necessary to carefully study and analyze the different materials out of which it is made, especially in salt water structures, but the question of impermeability must receive the closest attention in waters subject to frost action, be they fresh or salt; the problem reducing in the last analysis to the harmonious and united co-operation of the chemist and concrete engineers. North of Cape Cod a number of well-known failures have occurred in using concrete in dock and sea wall work, due to frost action upon permeable concrete. Serious difficulty has also been experienced at the Brooklyn navy yard with the use of concrete in one of the dry docks; the exact cause of which does not seem to have been fully discovered. On the other hand, in the port of Dundee, Scotland, where the climate is said to be as severe as in Boston, concrete pile docks are stated to have proved a success, with no injury to the piles due to their standing in frost-affected sea water.

After the dock engineer has satisfied himself that concrete can be successfully used in sea water structures, and that a concrete dock can be made a practicable engineering structure, questions of comparative initial cost and annual upkeep charges become a serious problem for him to consider—the more interesting the deeper one goes into it.

The annual overhead charges on a wooden dock structure, due to sea borers and to natural decay on account of dampness and severe treatment, are most excessive. Multiplied by the number of years a wooden-pile, wooden-deck dock will last in teredo-infested water, and added to the cost of rebuilding, the total charge against the wooden structure, steadily increasing with the beginning of each subsequent dock period, becomes of more vital importance, compared with a similar set of figures covering concrete docks (with no rebuilding) than does the difference between the first cost of the concrete dock and of the wooden pile structure when located in teredo-infested water.

Not only must the practicability of using cement in sea water and the advisability of using wooden piles in teredo-infested harbors be carefully studied by the dock engineer, but questions of type of design, first and rebuilding costs, fixed overhead charges, such as maintenance, fire insurance, taxes, interest on investment, refunding of bonds, operation expenses, etc. (entitled for the want of a better name, "dock finance"), must be carefully weighed, one against the other, as affecting wooden dock versus concrete dock construction; all without losing track of the fact that no matter what the type, or what the design, unless the dock will stand up and do its duty, the less the number of docks built the better for the community.

Concrete Docks Extensively Used in European Ports

America being a forested and non-maritime country has hitherto been far in the rear compared with foreign nations in the development of her port facilities. While England is absolutely dependent upon her shipping for an existence, Germany and other European nations are depending upon shipping for their raw materials and for the exporting of their finished products. Thus European ports with vast and up-to-date shipping facilities are far in advance of those in this country. Whereas European nations have not made such extensive developments of reinforced concrete dock construction as England, in England are found a large number of such structures, some of vast size and costing many hundred thousand dollars. In fact, there is hardly a port in England in which reinforced concrete docks do not exist, most of them having proved a success, constructively as well as commercially. If reports of the English dock engineers are true, the annual maintenance cost of concrete docks is about one-tenth of 1 percent—practically nil. This compared with figures quoted for New York harbor docks, and actually experienced for Puget Sound structures, is a most marked figure.

Now that oil fuel is becoming so generally used in the American merchant marine, especially on the Pacific Coast, it is fitting to speak of a new item that presents itself in a discussion of concrete docks versus wooden docks. Suppose the oil fuel became spread out on the water underneath a wooden structure, and accidentally became ignited, would not a conflagration be liable to start that might mean the destruction of property worth far more than the difference between the cost of a wooden and concrete pile structure? Even of recent date wooden pile docks have been destroyed by fire, and no one knows which one will be the next. It is unnecessary to recall the disastrous fire at the Hoboken docks some years ago or of the destruction of the Newport News piers by fire in 1897. Wooden docks will burn even if they do stand in water, and the results of a sea of fire under and around a wooden structure can be better imagined than described.

With due respect to the American dock engineers, it must be admitted that in the adaptability of reinforced concrete the European engineers are far in advance of their American contemporaries, especially in the use of concrete in sea water structures. Still a review of the concrete docks built in this country since 1906 will show at least thirty-six such structures of various types of construction now in operation, all no doubt having fulfilled the expectations of their designers, so much so that their numbers are steadily increasing on all three of the coasts of the country, viz.: Atlantic, Gulf and Pacific, not omitting the Great Lakes. Without doubt they will continue to do so, as their worth has been proved by actual experience, with semi-concrete docks as well as full concrete structures of various types and designs.

National Marine Engineers' Beneficial Association.—At the thirty-ninth annual session of the National Marine Engineers' Beneficial Association of the United States of America, held in Washington in January, the following officers were elected for the coming year: National President, William F. Yates, New York; First National Vice-President, E. C. Mausshardt, San Francisco, Cal.; Second National Vice-President, George H. Bowen, Port Huron, Mich.; Third National Vice-President, C. N. Vosburgh, New Orleans, La.; National Secretary, George A. Grubb, Chicago, Ill.; National Treasurer, A. L. Jones, Detroit, Mich.

Handling Steamship Package Freight

Limitations of Overhead Crane and Telpherage Systems—Advantages of Electric Trucks for Overcoming Congestion at Steamship Piers

BY WILLARD C. BRINTON

The time required for unloading and loading a ship usually depends on how rapidly work is handled in the small space on the pier immediately opposite the hatch. In this small space, usually not over 15 feet square, drafts of goods must be received or must be made up for hoisting. As most piers are of but a single story, and the ships of to-day have high sides, drafts of goods from the ship to the pier must be lowered with care or workmen will be injured. Material placed on the pier in sling loads must usually be picked up, package by package, and moved to the proper piles on the pier. It is this picking up of individual packages which delays the work when unloading.

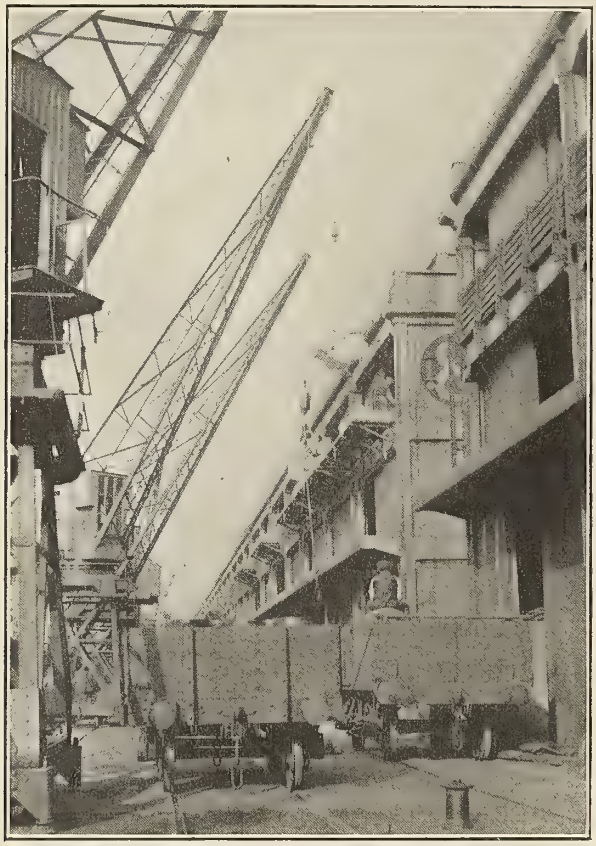


Fig. 1.—Unloading American Flour at the Three-Story Concrete Pier Sheds of the Manchester Ship Canal Company, Manchester. Note the Cranes Waiting Because the Bags Are Not Taken Away Rapidly Enough

The hand truck is a universal tool by which outbound material is moved from different parts of the pier to the side of the ship. Though the hand truck is a wonderfully universal instrument, which is assured of use far into the future, it has serious limitations. The ship's tackle in America, or the harbor crane in Europe, has progressed to such an extent that they have completely outgrown the hand truck. It takes several hand-truck loads to make up one load for the hoisting machinery. As a result, the usual practice is to lay down a sling on the floor of the pier immediately opposite the hatch, and then load into this sling material from several different hand trucks. Only one sling load can be made up at a time, and the ship is kept waiting longer than desirable. At most stages of loading a ship it is possible to stow material into the hold faster than sling loads are made up one at a time on the pier. Though there may be plenty of room on the pier as a whole, the only space which counts is that immediately opposite the hatch. Only a few men can work in this space, and it is not easy to improve conditions as long as sling loads are made up at the side of the ship.

It is seen, then, that the time in handling cargo, both in unloading and in loading, depends upon the speed of handling in the small space on the pier immediately opposite the hatch.

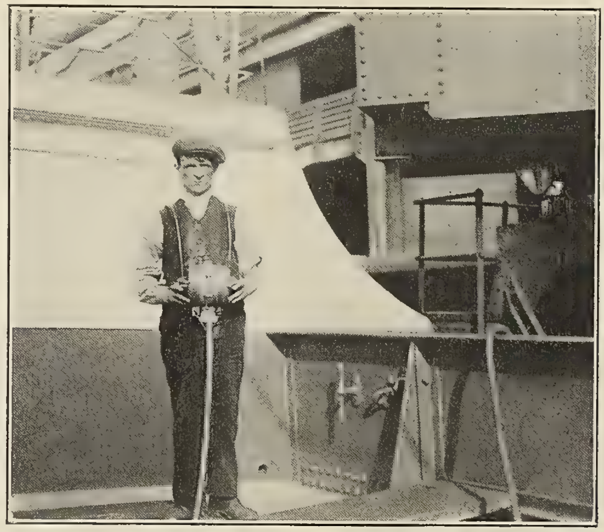


Fig. 2.—The Holmes Patent Controller, Used for Harbor Cranes, Manchester. One Man Carrying the Controller Can Do the Work Formerly Requiring Two Men for Each Crane. The Crane Operator is on the Ship Where He Can Look Down into the Hatch. Because of the Instantaneous Crane Control Time is Saved and There is Increased Safety for the Workmen

It is possible to put on an almost unlimited number of stevedores radiating from the side of the ship to different parts of the pier. It is also usually possible to put on more men in the hold of the ship so that several sections in the ship may be worked simultaneously from any hatch. The hoisting tackle is sufficient in capacity to make many more trips per hour than it usually does make. It is the space on the pier opposite each hatch which causes the restriction on rapid freight movement. This small space could be likened to the neck of a bottle, or rather to the neck of an hour-glass, which entirely fixes the time required for material to pass from one side to the other.

The cranes used for handling freight at European seaports do not solve the problem. The crane only transfers the congested area from the immediate side of the ship to a point 30 or 40 feet away where the crane receives or delivers its load. The same problem of assembling sling loads, or of separating packages from a sling load, appears at the point where the crane ends its travel at the shore side of its total movement. The use of cranes does not affect the speed in any way in this particular phase of the work, for the crane is essentially the same as the ship's tackle used in burtoning.

Theoretically, the overhead telpherage system might solve

the difficulty if the overhead telpherage system is laid out in such manner that material could move between the hatch and any part of the pier without stopping at the side of the ship. The space on the pier immediately opposite the hatchway could be neglected entirely if we had high-speed telphers working on a track loop which could be placed from the side of the pier over the hatch. Whether telphers will ever be widely used in this manner for mixed freight of many marks is, however, very doubtful. There are serious limitations to flexibility we should desire if an overhead freight-handling system were to be installed. Let our imaginations gallop, however, and assume for the moment that we have available to-day high-speed overhead telpherage apparatus of an, as yet unattained, ideal type. Such an ideal telpherage system could not be installed in the average pier shed found in America, for the reason that the head room is not sufficient. If the telpherage system were installed in the present pier sheds, there would not be sufficient height for piling goods beneath

Fig. 3.—Receiving Goods From a Crane at the New Harbor of Antwerp, Belgium. The Speed of Unloading the Ship is Limited to the Speed at Which Goods are Handled on the Small Platform. Note the Scales With Equal Length Beams and the Women Assisting in the Work

Fig. 4.—Teams Delivering Outbound Freight to the Piers of the New England Navigation Company, New York. The Teams Unload Onto a Low Platform Without Going on the Crowded Pier. Storage Battery Trucks Take the Freight From the Narrow Receiving Platform Directly into the Steamship. Time and Space are Thereby Saved

even the most ideal machinery which can be imagined if that machinery must run on tracks. It is only by abandoning the idea of tracks that absolutely free movement can be obtained.

Telpherage systems have not been developed to a great enough extent for us to have available to-day a complete line of apparatus which would have the high speed and extreme the telpher to give an economical pier for operating, taking into consideration the very great investment due to the telpherage system alone. In order to get the right kind of conditions for operating a telpherage system we must ordinarily have a completely new pier shed with greater overhead clearance than found in the average shed now in existence.

There are in America alone several billion dollars' worth of pier sheds fairly new and in no danger of going to the scrap heap because of the advent of the overhead telpherage system. It is toward the better utilization of present pier sheds that this discussion is directed.

Harbor improvement is usually taken to mean the building of more piers. Though more piers are sometimes needed, it would be far more desirable, from every standpoint if freight could be handled 20 percent more rapidly on existing piers than to have 20 percent more piers built. The interest on investment, the depreciation, obsolescence and operating charges on dredged docking space, ships, piers and cargo (both inbound and outbound) are simply astounding. If the business could be handled in such a manner that even a small reduction could be made in the time the ship remains at the pier the financial returns would be enormously increased. Practically no consistent study has been made toward better utilization of existing waterfront equipment. Any manager who will give careful thought to the more rapid and economical handling of freight on his own piers may be assured that he will be well repaid for his effort.

The harbor crane of limited movement and the overhead telpher system limited to movement on tracks do not satisfactorily solve our problems. There is now available, however, a new type of machinery capable of wide application. This is the electric freight-handling truck. Electric storage battery trucks of small size suitable for pier use are so new that pier superintendents have not yet placed them in service, where they could give very handsome profits on the relatively small investment required.

Consider the unloading of a ship if electric storage battery trucks are used on the pier. The sling load of material, swung from the ship's side by burtoning, is lowered directly onto the back of an electric freight truck of 2 tons capacity. The electric truck moves the whole sling load of material away from the side of the ship and another electric truck immediately comes into position to receive the next sling load. A small number of electric trucks is enough to relieve the weakest link in the chain, which in the past has been the limited space on the pier immediately opposite the hatch. A pier manager, with an equipment of electric storage battery trucks, can safely offer to take the material away from the side of the ship as fast as the men on the inside of the ship can send the freight over the side of the ship.

There is no necessity for smashing up valuable electric trucks by dropping heavy articles out of a sling onto a truck waiting to receive the sling load. The drivers of these electric trucks have their machines under such nice control that they can easily wait a short distance away from the side of the ship until the sling load is lowered to within a few feet of the pier floor. The driver then comes forward with his truck, receives the sling load, and immediately moves away from the side of the ship, carrying the sling and all. On some commodities it is possible to take two sling loads to one truck load, so that the electric truck waits until a second sling has come over the side of the ship.

Sorting into many marks is, of course, the bane of rapid and economical freight handling. The sorting is, however, no worse with the use of electric trucks than it is without the electric trucks. There is a tremendous advantage with the use of the electric truck, in that the sorting is transferred away from the side of the ship where there is danger to workmen because of falling packages. The sorting is done where there is an unlimited amount of room with no danger to stevedores.

In every cargo there are certain large marks which can be sent out of the ship in complete sling loads. These sling loads of one mark can be moved by the electric truck directly from the side of the ship to the proper pile on the pier. Even for those marks in the ship which are not of large size, it is frequently possible to handle the work inside the ship in such manner that some sorting can be done on the inside, so that slings are sent up of one mark only or, at most, two marks in a sling. The sling load of two marks can be handled economically with the electric truck, as it is only necessary to deliver to the proper pile material from mark one and then run the truck to the pile of mark two. With an electric truck capable of short turning radius, movement on the pier is so easy and rapid that it is cheaper to run two separate piles with an electric truck carrying a whole sling load than to have stevedores carry the freight, package by package, to the proper piles.

The electric truck is especially advantageous in moving material through long distances, such as when delivering freight from the side of the ship to the "farm" at the shore end of the pier, or direct to warehouses. On such work the electric truck can do the trick more cheaply and far more rapidly than it can be done with mules. There is an especially great advantage, in that the electric truck can be maneuvered in such a manner that it can come to the side of the ship to receive a sling load without any delay whatsoever. Mule-drawn trucks have a large turning radius, and it is impossible to back the ordinary truck when using a mule. The result is that mule trucks must be pushed by hand up to the side of the ship to receive freight, causing very serious delay to the whole job and an expensive operation, because of cost for stevedores, mules and drivers.

Another advantage of the electric truck is that it can be run directly over platform scales for weighing the freight as it comes from the ship. Electric trucks can be driven so accurately and rapidly that they can be taken to a dormant scale at some point on the pier with almost negligible cost for running the distance required to get to the scale. It is not feasible to drive mule trucks over a scale, for the reason that the trucks are very inaccurate in the direction of their movement, and they cannot be stopped accurately because they have no brakes. When electric trucks are regularly used on a pier, it is advisable to have a number of portable platform scales which can be placed at any point desired. These scales are about 15 inches high from the pier floor, and are reached by an inclined plank from either end. The electric truck simply runs up the plank incline, stops a moment on the scales while the weight is taken, and proceeds to the pile, the freight car, the lighter or the warehouse. Portable platform scales of the type described cost but a small sum, and they will weigh freight in truck loads of 2 tons more accurately than the weigh masters' beam so commonly used by merchants and by the United States customs officers.

In European harbors it is not unusual for 60 percent of all the freight taken from a steamship to be handled directly from ship to freight cars without ever touching the pier floor. Freight cars in England and Continental Europe are, however, very commonly of the open type, using tarpaulins for rain protection. Cranes swing the freight direct from the ship to the open cars. In America, where much of the material must be weighed, either for purposes of the merchant or for the customs officers, the electric truck and the portable platform scale can be used very cheaply between the ship and the freight car. If the railroad tracks are at the center of the pier, or at the end of the pier, we can transfer package freight between the ship and the railroad box-car by use of the electric truck, without having to build new piers and new pier sheds for telphers and without having to install harbor cranes. There are real advantages in having a pier shed built out to the side of the pier. Most of the pier is then protected from weather at all seasons, and there is less danger of freight being damaged by rain than if there were a wide open space between the side of the ship and the pier shed, as usually found on European piers using harbor cranes with exposed railroad tracks on the outer edge of the pier.

When loading a ship by electric trucks the operations are almost exactly the reverse of those described above for unloading. The sling is laid on the back of the truck as the truck stands beside the pile of freight on the pier. Freight is piled onto the sling, and the sling load made up completely, with the rope looped through, before the electric truck leaves the pile. When the truck reaches the side of the ship all that is necessary is to put the hoisting hook into the loop of the sling rope and hoist away. The moment the draft leaves the back of the electric truck the electric truck moves out of position, so that there is no danger to the truck even if some of the heavy packages do fall out of the sling through a distance of 15 feet or more. By the arrangement outlined it is possible for a dozen or more sling loads to be made up simultaneously. Each sling load is assembled on the back of an electric truck so that the sling load can be moved from the pile to the side of the ship without congestion. There is no expensive interference due to crowding of workmen and there is no delay to the ship. The speed of loading the ship depends entirely on how many men can be placed in the hold of the ship to stow the material.

As a general thing, it may be said that if electric trucks are used ships may be unloaded as fast as the package freight can be thrown over the side of the ship, and they may be loaded with package freight as fast as material can be stowed inside the ship. The limitations of speed need not be on the pier. The only limitations to speed are those due to the nature of the cargo and the number of men that may be used inside the ship for handling that cargo. A satisfactory electric truck must, of course, have a very short turning radius. It must have great flexibility of control and it must be built for rugged work.

Taking into account the incidental gains due to the increased volume of work which may be obtained from ships and from steamship piers, electric trucks of the type described can save on the average busy steamship piers a sum of money which is a princely return on the investment in trucks. The day of the electric dock truck has dawned and is already bright with achievement.

LIST OF BOILER MANUFACTURERS.—The Supply Men's Association of the American Boiler Manufacturers' Association has recently compiled and published an authentic list of the boiler, tank and stack manufacturers and steel plate users of the United States and Canada, in neat booklet form, which is now ready for distribution. Manufacturers of boiler materials, boiler manufacturers' supplies, tools, etc., can secure copies of the book for the sum of $3 (12s. 6d.) by addressing the secretary, Mr. F. T. Slocum, West and Calyer streets, Brooklyn, N. Y.

ANNUAL MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.—The annual meeting of the Institution of Naval Architects will be held in the Hall of the Royal Society of Arts, John street, Adelphi, W. C., London, on April 1, 2 and 3. The annual dinner will be given on Wednesday evening, April 1, in the Grand Hall, Connaught Rooms, Great Queen street, Kingsway, W. C.

Special Installation of an Electric Hoist on a Steamship Pier

About a year ago the Shepard Electric Crane and Hoist Company, New York, installed on Pier No. 80, North River, New York, for the Central Railroad of New Jersey an electric hoist, which has a rated capacity of 10 tons, for use in unloading heavy units of freight from cars on car floats. This hoist operates on 220-volt direct current supplied by means of flexible cable. This arrangement is rather unusual and was adopted in this case on account of the purchaser's desire to avoid bare wires on the dock.

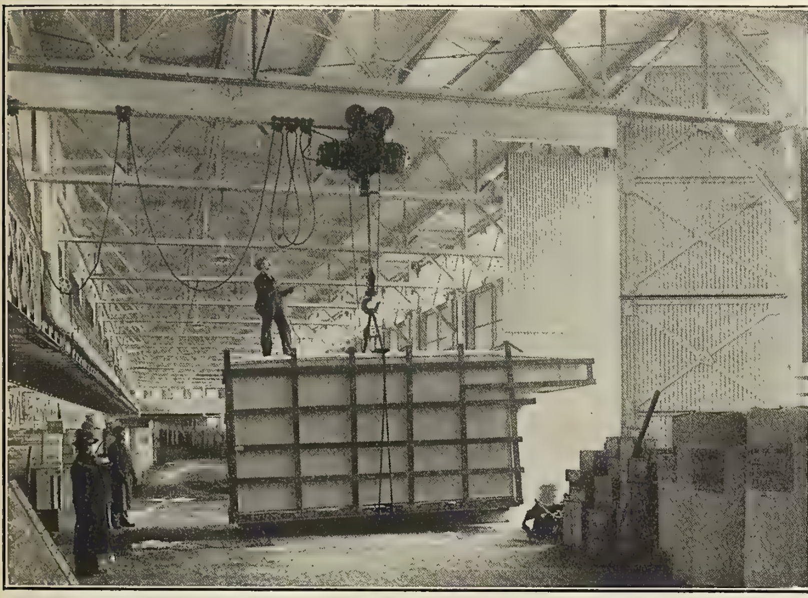


Fig. 1

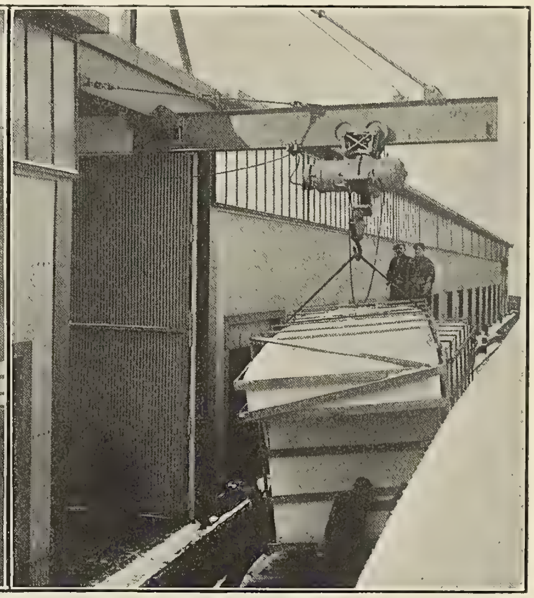


Fig. 2

An interesting feature of the installation is a jib projecting out over the car float. As can be seen from Fig. 2, this jib is hinged so that it can be brought to a vertical position when not in use and in this way avoid interference with vessels having standing rigging.

The method of raising the jib is unique in that it is accomplished by means of the hosting motion of the electric hoist itself. A steel cable is attached near the end of the jib and carried over a series of sheaves to a snatch block directly under the hoist when standing just inside the doorway. The ring on the end of this cable is thrown over the hoist hook and the jib raised by the upward motion of the hook. The cable is then firmly secured and the jib held in a vertical position. The lowering of the jib is accomplished by the reverse operation.

This hoist has been found to be very successful in service, due in a large measure to the complete protection afforded the gearing, brakes and bearings and the operation of these parts in baths of clean oil, completely protecting it from dirt and weather.

River Terminals for Inland Cities

Unit Plan Proposed for River Terminals—Quay Construction, Sheds and Freight Handling Machinery Described—Unit Capacity and Costs

BY H. McL. HARDING *

At many river cities of moderate size, as upon the Mississippi and its tributaries, between the business portion and the water's edge, there often intervene railway tracks and the railroad rights of way. Between these tracks and the river usually there is available, including the levee, an area, the width of which is from 125 to 160 feet. On account of the convenience of these locations for shipping and receiving freight it is generally desired to establish here the industrial or local freight water terminal of the city.

In the sketch printed on page 113 are given the end and front elevations and the plan of a river terminal with a quay wall section. These are intended only to give the general idea of a river terminal and the relative positions of a few of the terminal elements to each other.

General Application

The plan secures a greater efficiency per lineal foot than is regarded possible with projecting piers, although this sketch should not be regarded as directly applicable to any particular locality, as modifications would probably be necessary.

To design any terminal correctly there would be required exact measurements, horizontal and vertical, a knowledge of the traffic conditions and the freight movements, and the character of what the wall foundation would consist, as well as the slope and width of the levee, and similar preliminary information upon which to base a correct conclusion and estimate.

Limiting Factors

This plan presupposes that there is here a width of about 150 feet. The tracks of the railroad company owning the right of way limit width extensions.

The terminal, if constructed in this space, must therefore conform to the land, which is limited in width, but the length can be extended in a direction parallel to the river.

City terminals, both for rail and water transportation, have such a marked influence on a city's growth and prosperity that nothing should be left undone to secure the best locations, which should be laid out according to correct plans and designs and to profit in equipping by the experience of others. The idea that for a progressive city a pile wharf is a terminal-asset or will add to the city's welfare should not be entertained.

Commerce Terminal

It is recommended that while there may be an industrial or local service terminal thus placed directly in front of the city, that some other location not so limited in space as this be selected for through or commerce freight, and that here, when the volume of the freight tonnage may warrant it, there be planned a large, complete terminal with its quay walls, its mechanical equipment, railway tracks, transfer and transit, sheds, warehouses, dray areas, classification and storage railway yards, industrial section, and connected with the all-important belt railway, which should have spurs leading to industrial works.

Terminal Investment Reimbursed

In not a few foreign cities large areas away from the city's center have been purchased, and that portion not needed for the terminal has been sold for industrial (chiefly manufacturing) purposes, at such an advanced price that the terminals, often requiring an investment of millions, finally cost such cities little or nothing.

Terminal Limitations

The greatly varied terminals are here represented as narrow and warehouses are not represented. This is due to the fact, as stated, that existing railway tracks and rights of way are close to the levees. The accompanying plan was designed with this limitation continually in view.

Warehouses

The warehouses should preferably be placed to the rear of the sheds and tracks, with overhead connections above the tracks; but where this is impossible they can be placed in a line with the sheds. There can be one warehouse in this case for each 600 feet; that is, one for each two units.

There should be a study therefore of each city frontage, so that the necessary modifications can be made.

Unit Lengths

The length of each unit is given as 300 feet, being a little longer than the longest river freight barge. It is better that 300 feet should be correctly designed, properly constructed and equipped, than that a greater length should be only partially completed, which would produce dissatisfaction of the shippers and consignees. In this 300-foot unit the shed may be made longer than given and wider if the land will permit, and there can result a changing of the proportions of space herein allotted.

Should there be sufficient room two railway tracks between the shed and the river may be added, making three tracks, and the arrangement of the rear tracks may be altered.

Lineal Foot Tonnage Capacity

It is not expected that 300 feet will be sufficient for a water frontage, as that length will only have a lineal transferring capacity during the seven months of from 30,000 to 45,000 tons, or from 100 to 150 tons per lineal foot. The next unit should be 300 feet more, extending along the levee, and each increase should be an additional 300 feet with shed and equipment.

The Unit Plan

By having a comprehensive plan in the beginning, the ultimate expense will be less, and all working parts will be interchangeable, and the machinery, consisting of a number of the cranes and transferring machinery, can be concentrated for quick loading or discharging service at any one unit.

If there should be only a small appropriation available for the terminal, the first 300 feet should be completed in every respect, and then the second unit can be added and equipped from a later appropriation. One thus completely equipped unit will be equal in capacity to two or even three units not so equipped.

There are, however, three types of these 300 foot-units, differing in first cost according to transferring and holding capacity and the character of the installation.

Costs Per Unit

The first type is illustrated in the sketches, and the average cost is about $160 (£33) to $200 (£41) per lineal foot, exclusive of the land, the railway tracks and the wall founda-

* Consulting and Designing Engineer, Freight Terminals, New York.

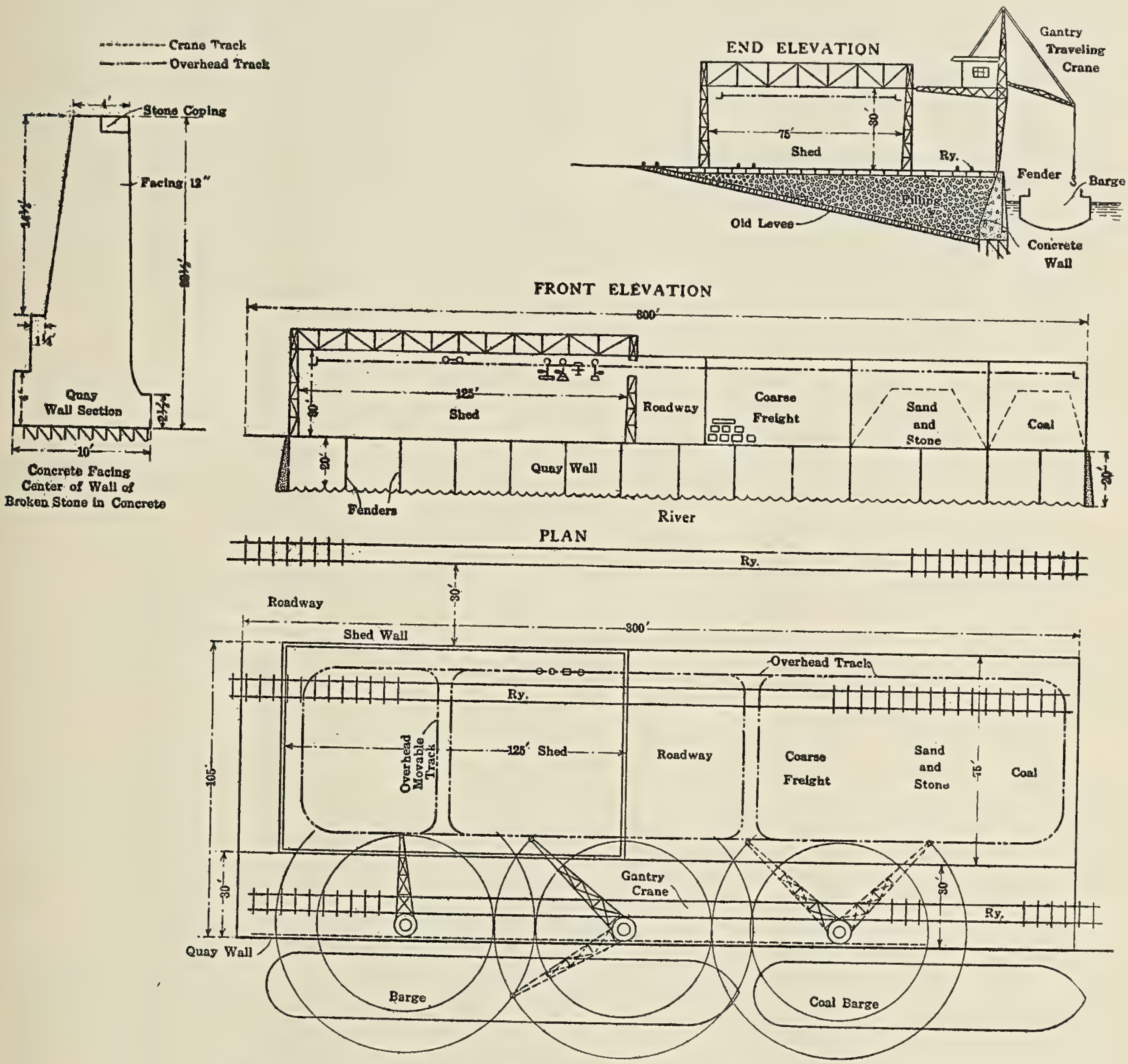
tions, the cost of the latter being only ascertained through borings. These foundations may add considerably to the cost, depending upon the difficulty in securing a solid foundation.

Quay Wall Section

There is given in the sketch a cross section of a quay wall to be placed upon the foundation. The quay wall, where there is a firm natural support, and the height is 22½ feet, may consist of a gravity concrete wall 10 feet wide at the base, 4 feet

vessels, or between the coal or coarse freight areas and the vessel. This traveling gantry crane being elevated is superior to the locomotive crane, in that it does not occupy valuable quay surface and has more freedom of movement.

There is a railway track shown between the shed and the quay wall, besides the track within the shed and the one to the rear of the shed. The locating of the front track will depend upon the ease of approach, and in some cases trestles before the unit is reached may be required.



Sketch of Inland Navigation Terminal. Unit Length, 300 Feet. Width Limited

wide at the top, with a slight batter, the dimensions as given varying according to the locality and the rise of the river.

The interior of the wall is of broken stone in concrete. There are between 5 and 6 cubic yards of concrete per lineal foot in the wall as shown, at an average cost of $8 (1/13/4) per cubic yard.

Traveling Gantry Crane

On the top of this wall is one of the tracks of the traveling gantry crane, the other track of the crane being attached just below the roof of the shed, as shown in the end elevation. This crane, as shown in different positions, transfers loads between the shed and the vessels or between the cars and the

Sheds

Thirty feet back from the water's edge is the shed, 125 feet long, 75 feet wide and 30 feet high below the cross girders. The shed, on account of high tiering, will have a holding capacity of about 2,000 tons of package freight. The tonnage of coarse freight in the open areas is not affected by the weather, and the bulk material is in addition to the 2,000 tons.

At one end of the shed is a roadway, and adjoining the roadway the open areas for coarse freight, bulk material, as coal, ore and sand. The relative positions of these can be changed.

Within the shed are operated the fixed and movable overhead tracks, the tractor and carriage hoists. Upon the land side of the shed there are dray areas.

Great Range of the Machinery

The movable tracks, as well as the tractor and hoists, can pass over the coal and coarse freight areas, and with the crane can serve these open areas. For example, freight can be lifted from the barge by the crane, be burtoned to the carriage hoists and carried to and tiered upon any place within the shed or open space.

Similarly the reverse movements can be performed. Clamshell buckets attached to the gantry crane or carriage hoists can handle coal, ore, sand and other bulk material to and from the barges. Coal as well as other material may be reclaimed as well as deposited.

Freight can be taken between open cars or the platforms of closed cars and the vessels. All of the above movements are performed equally well in either direction by the machinery, smoothly, rapidly, economically and with the minimum of manual labor.

Increased Capacity Due to High Tiering

High tiering of package freight and high piling of coal, sand, etc., may be said to triple the storage capacity of the terminal.

In the front elevation, as drawn, which is parallel to the river, is the nearly vertical quay wall, the shed, the open areas and the longitudinal overhead tracks. It is urged that this view of the water front should be made architecturally pleasing, attractive and a credit to each city, even though the expense should be a little more. In this elevation the wooden fenders are outlined in front of the wall.

In the end elevation is the old-paved levee slope, the filling preferably pumped from the river channel, the paved surface of the quay, the shed, the crane and the transverse movable overhead track.

After the specifications for a location have been prepared and preliminary estimates received, exact figures and all details can be furnished. These should be a complete report for each city with complete specifications and full estimates.

Second Terminal Type

In cities of the intermediate class with a terminal of the second type, the dimensions are similar to those of the first class, but the quay frontage is of steel piling, the shed of more simple construction and there is less hoisting machinery. The cost will be $120 (25/0/0) to $160 (33/6/8) per lineal front foot.

Third Type

The third class, for mere ports of call, consist of a wooden structure, simpler hoisting and conveying machinery, but no crane, a small, narrow shed, with only one track. The cost will be from $30 (6/5/0) to $50 (10/8/4) per lineal foot.

Total Terminal Costs

The total cost of a terminal depends upon the estimated tonnage to be transferred, which determines the number of units of 300 lineal feet. By the use of approved mechanical methods a greater tonnage (often double) can be transferred over a given lineal frontage than has been usually achieved in the United States. This would signify that the installation of such machinery would reduce the terminal investment for a given tonnage to one-half. That is, a terminal, correctly designed and equipped, if 900 feet in length, should be equivalent to one of 1,800 feet not equipped.

This advantage is in addition to the resultant economy also due to the freight-handling mechanism, besides the all-important fact that barges can be discharged and loaded in less than one-half the time usually consumed.

Conclusions

The following conclusions are inevitable:

1. That there must be a change from the old types of terminals, and from the former methods of handling the freight, to secure greater rapidity in the freight movement and economy in the operation.
2. That unless this rapidity and economy be secured most of the great potential advantages of water transportation cannot be attained.
3. That by serving by freight-handling mechanism, all space of the terminal, without rehandling, including loading, discharging and mechanical tiering, both rapidly and continuously, the desired results are obtained at properly designed and constructed terminals.
4. That the passenger traffic, as with the railways, is of less importance than the freight traffic, and where possible the freight and passenger traffic should be separated.
5. That where there cannot be free vertical movements of the freight, 50 percent more time will be required at a 50 percent additional cost. Hence the type of boat is of importance.
6. That the entire transference between barges and cars should be by machinery as well as the other terminal movements, as assorting, distributing and tiering.
7. Terminals should be designed to be constructed in units, and such that the maintenance should continue to be a minimum amount.

Gasoline (Petrol) Pilot Boat.—Three gasoline (petrol) boats have been built for the Isthmian Canal Commission by the Gas Engine and Power Company and Charles L. Seabury & Company, Consolidated, Morris Heights, New York City. Two of these boats are now in the commission's service at Panama, and the third has just been completed. These boats are of the open type, especially designed for pilot service in rough water, with a slightly curved bow, a full underbody and a "whaleboat" type stern. The length overall is 35 feet, the beam 7 feet 6 inches, and the draft 3 feet. Propulsion is by a 4-cylinder, 4-cycle, 6-inch by 6-inch Speedway motor of 38-48 horsepower, which gives the boat a speed of 10 knots. Forward the boat is decked over for a length of 13½ feet, forming a safe and comfortable landing stage for the pilot. Aft is a cockpit 11 feet long, while between the cockpit and the forward deck is the motor compartment. A gasoline (petrol) tank of 125 gallons capacity is placed between watertight bulkheads forward of the motor. There is also a large storage space forward of the tank.

Cantilever Crane for Lumber Dock

On the shipping docks of the Hammond Lumber Company, Astoria, Ore., are installed two 5-ton Brownhoist cantilever cranes for loading and unloading lumber vessels. A general view of the company's piers is shown in Fig. 1. There are in all two piers, each 450 feet long and 140 feet wide. About seventy million feet of lumber is shipped from these docks each year. The crane in the background of Fig. 1 has been in operation several years, while the one in the foreground is a newer type, having been in operation only one year. The lumber is delivered to the dock from the mills on two tram machines, and is distributed over the dock by the cantilever cranes to await shipment. The cantilever cranes are electrically operated and travel the entire length of the face of the dock at a speed of 400 feet per minute with a full load of 5 tons.

As can be seen from Fig 2, the crane consists of pier construction with traveling trucks and with a cantilever extension on each side covering the entire width of the dock. A Brownhoist man-trolley travels crosswise on a runway along

Fig. 1.—Shipping Docks of the Hammond Lumber Company, Astoria, Ore., Equipped With Cantilever Cranes

these two cantilevers at a speed of 250 feet per minute with full load. A lumber unit of 5 tons is hoisted at the rate of 50 feet per minute. The trolley and the entire crane is operated by the man in the trolley cage.

The lumber is installed in sling loads of approximately 3,000 feet each. The crane is equipped with a platform containing six traveling endless chains, as shown in Fig. 2. This allows eight units to be put on the crane at one time, and the traveling chains carry the different units beneath the trolley, where they are picked up and put upon the dock.

The lumber is loaded into the ships by the ship's windlass, and the crane is equipped with a hinged apron, which can be extended over the ship so that the trolley can load the lumber direct into the vessel or the apron can be raised to allow the boats to dock. At the present time, the ship's windlasses are used for loading at the docks, because the receiving end is not yet equipped with unloading machines.

The crane shown in Fig. 2 will load 300,000 feet of lumber per day. At the base of the crane boom there is a platform on which 24 tons of lumber can be loaded and transported by the crane at the designed speeds. The lumber is piled on the dock to a height of 20 feet, which allows much more storage than is possible when hand labor is used. There is also a great saving in the wear and tear of the dock by the elimination of the teams. When teams were used in carrying lumber from the dock, it required from 6,000 to 10,000 feet of lumber per month for the dock upkeep, the elimination of which is no small saving.

Fig. 2.—Special Type of Cantilever Crane for Handling Lumber

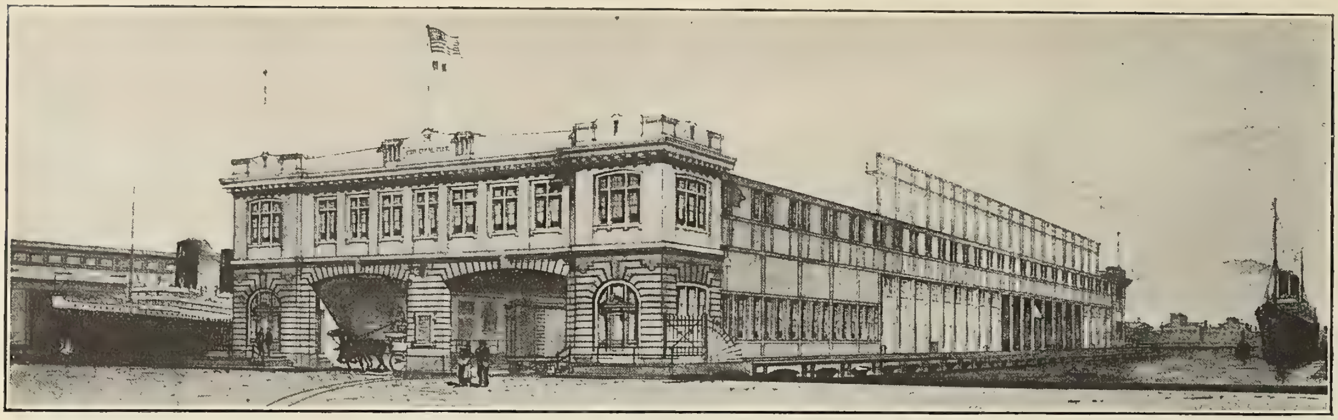


Fig. 1.—General View of New Municipal Pier in Philadelphia

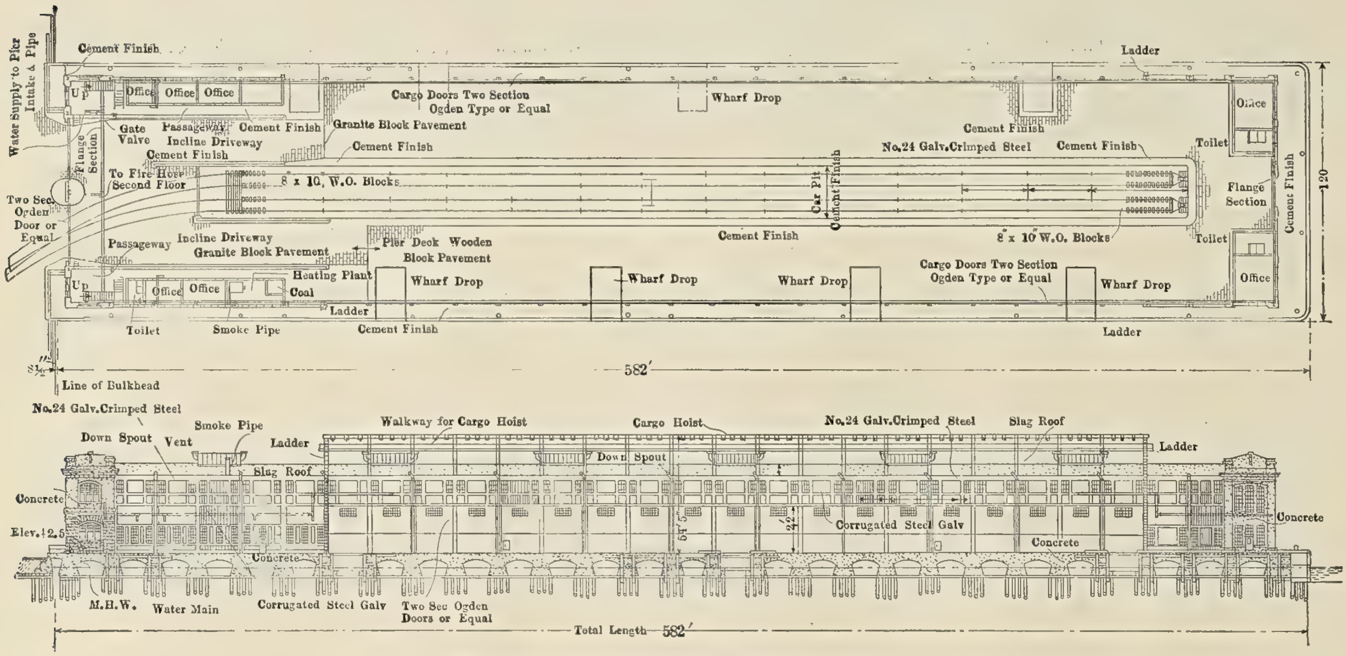


Fig. 2.—First Floor Plan and Side Elevation

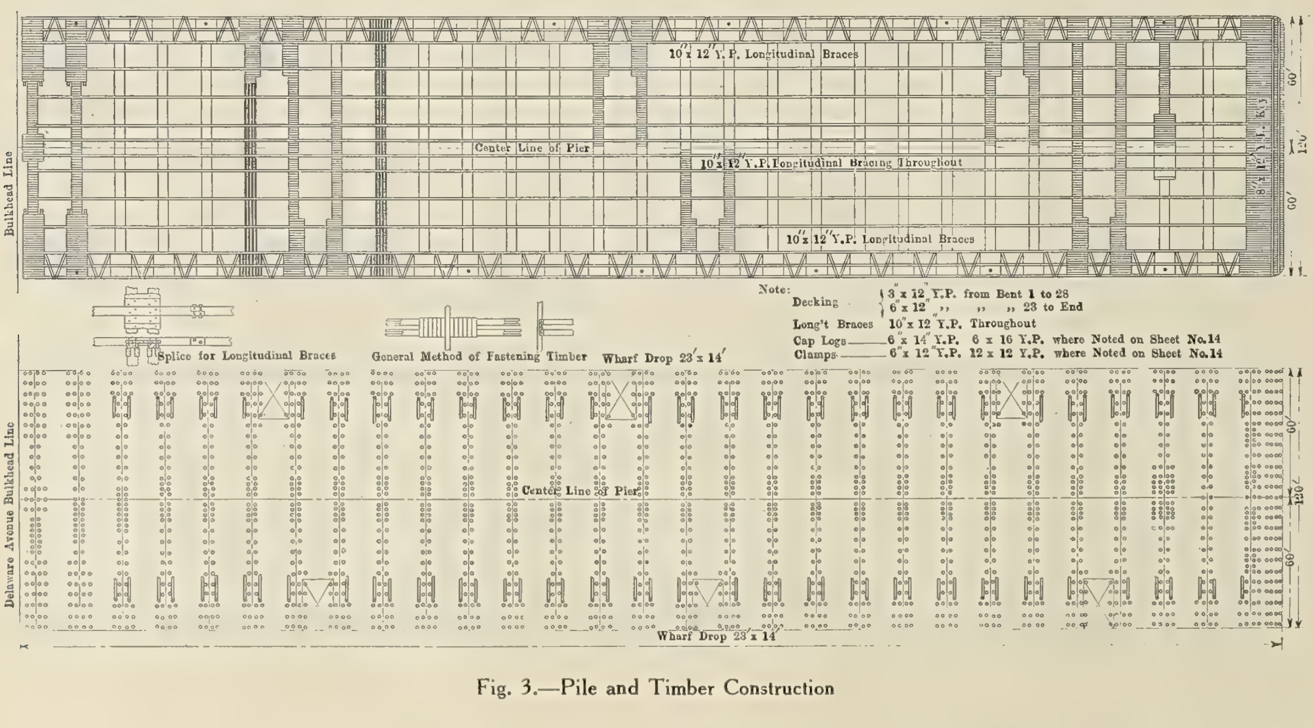


Fig. 3.—Pile and Timber Construction

New Municipal Pier in Philadelphia

Large Steamship Pier Erected in Philadelphia to Relieve Congestion in Shipping—Construction of the Pier and Facilities for Handling Freight

A new municipal pier, costing about $335,000 (£68,700), was opened recently at the foot of Dock street, Philadelphia, Pa. The pier is 582 feet long by 120 feet wide and is located in the center of the present shipping district for the purpose of relieving the congestion at this point until other steamship terminals are erected in the southern section of the harbor.

The substructure of the pier is of the timber pile and concrete cross wall type. The piles are cut off about 2 feet above the mean low water level and clamped, capped and decked in bents upon which are placed solid concrete cross walls. The sides of the superstructure are concrete walls with arched bays and the dock is designed to carry a load of 600 tons per square foot. It is paved with wood blocks and two types of Hassam pavement.

The superstructure is a single-story shed of steel, reinforced concrete and corrugated iron construction. It is 106 feet wide, leaving a working space of 7 feet outside of the superstructure on each side. The sides of the superstructure are of the open type, equipped with Ogden steel folding doors in every panel except for a few bays at each end of the structure. At the in-shore end of the pier is a second floor to accommodate the officers of the several steamship companies using the pier.

In the center of the pier is a depressed double car track, which has a capacity of 22 cars and allows freight to be trucked into the cars without a lift. At the in-shore end the deck has two inclines—one on either side of the car tracks—to allow wagons to enter the pier.

The freight is handled from the ships by elevated cargo beams, located above the roof of the shed, to which the tackle may be attached for "burtoning" the cargo either from or into the vessels. Portable electric winches are provided on the pier deck to supplement the ship's tackle in handling cargo. Numerous wharf drops also allow the ships to unload through side ports when they are constructed in such manner as to be able to do so.

The northern half of the pier was rented before its completion to a newly formed corporation named the Philadelphia Piers Company, which is engaged in the general business of wharfage and stevedoring. Among other steamship lines they are at present handling all of the ships of the Austro-American fleet from Mediterranean ports. The other half of the structure will be reserved as an open pier for the present until the completion of additional municipal piers, accommodations being furnished to all comers in the order of their arrival or application for berthing space.

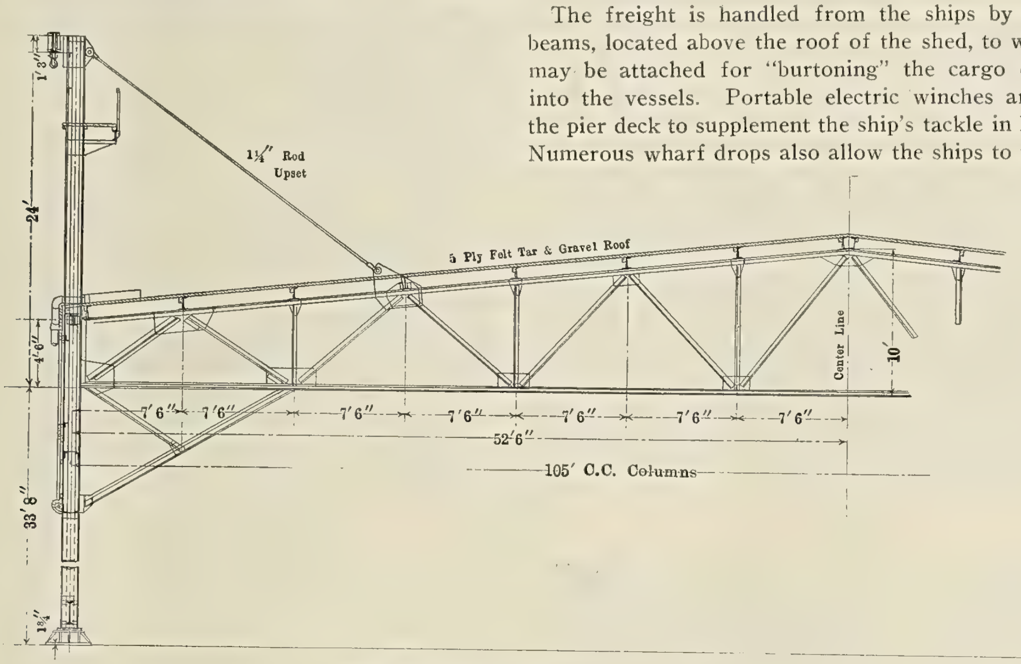


Fig. 4.—Pier Shed Construction

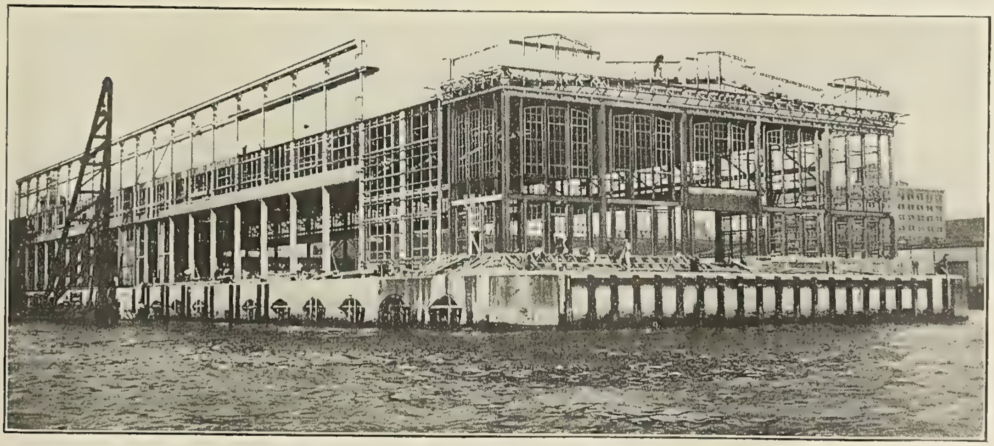


Fig. 5.—View of Pier Two Months Before Completion

Electric Trucks on Steamship Piers

Some pertinent facts regarding the deplorable congestion of freight at New York docks were brought out in a recent issue of the *Commercial Vehicle*. It was pointed out that in handling freight at the steamship terminals along the west waterfront of New York City a tremendous loss of time occurs on account of inadequate facilities at the terminals. The cramped facilities are due primarily to the fact that the city had so rapidly outgrown its original plan that it has been impossible heretofore for the docks to keep pace with the the increase in traffic. The docks were originally designed for conditions existing at the time the majority of them were

Fig. 1.—Elwell-Parker Electric Storage Trucks in Service on Steamship Pier

Fig. 2.—General Vehicle Company's Electric Trucks Handling Packages

built. As the city has grown, the traffic in freight has increased steadily and relentlessly, while the facilities afforded on the riverfront are little it at all improved. Long ago outgrown, the water terminals are becoming year by year so dwarfed that the loss of time due to congestion seems to be reaching an almost critical stage.

The direction in which this condition can be remedied lies, it is claimed, in the provision of improved transportation appliances; in the fore rank among these appliances stand the commercial vehicle, the electric industrial truck, the overhead telpherage system of freight moving and the gravity conveyor. Of these appliances, it is maintained, the motor truck must assume the premier position as the connecting link between the dock and the merchants.

By more thoughtful arrangement of incoming and outcoming freight at the terminals the transportation agencies can relieve the congestion and make it possible to handle more business and do it more economically. One company, the New England Steamship Company, realizing the value of better facilities for handling freight, has so far solved the problem at their end that practically no loss of time is necessary. This has been brought about by the use of electric industrial trucks or electric stevedores, as they are sometimes called, and the fact is significant that, while there is probably no other dock in New York handling the volume of business of this one so free of congestion, nevertheless, with less street frontage, it handles 50 percent more tonnage per day than another well-known dock in its immediate neighborhood. The unloading platform force is greatly reduced by the intro-

Fig. 3.—Battery Truck Crane Made by the General Electric Co.

duction of the electric industrial truck, and the expense of maintenance is not high. The New England Steamship Company has twenty-one of these trucks, nineteen of which are of one-ton capacity, whereas the others are of two-ton capacity.

Each one of these industrial trucks has displaced five men, whose wages were each $3 (12s. 6d.) per day. In this respect alone these trucks are saving their owners $63 (£13 2s. 6d.) per day, or a total of $18,900 (£3,880) per year. In addition to this saving the economy of time effected by these vehicles is incalculable. A small truck with a crane for lifting heavy weights is a valuable feature of these trucks, as it performs valuable service in lifting pieces of machinery and other heavy goods.

A further instance where congestion has been relieved by a rearrangement of the methods of handling incoming and outgoing freight is cited in the case of the Old Dominion Line, where a novel system of receipt and delivery of goods from the street has been adopted. One of its platforms is fitted with overhead chutes leading from the floor above, from which goods are received by the trucks or wagons after they have discharged their loads on the street-level platform. A truck having an outcoming shipment and an incoming consignment may back up to one platform, discharge the outgoing load and receive the incoming load without moving. The gangs which handle the goods are separate and distinct, being on different floors. The platform space required for the two operations is practically cut in two, and the frontage of the dock is about half that required under the old system. The pier is used solely for the transfer of cargo to and from the ships. All incoming cargo as taken from the ship is sorted; that for transfer to railway floats, lighters or other ships is held on the lower level, while that for city delivery is lifted to the loft by escalators.

Further evidence of the greatly increased efficiency resulting received 30 cents (1s. 3d.) an hour, 50 cents (2s. 1d.) an given in a recent issue of the *Railway Age Gazette*. One instance cited referred to the use of eight electric trucks on the Cunard Line piers in New York, which, with eight operators, replaced a force of thirty-two handtruckers. The laborers received 30 cents (1s. 3d.) an hour, 50 cents (2s. 1d.) an hour after 6 P. M., and 60 cents (2s. 6d.) an hour on Sundays. The labor saving occasioned by the use of the eight trucks for the first day's work of nine hours was $87.60 (£18 5s. 0d.), or $1.22 (5s. 1d.) per truck per hour. With a long haul this can be increased, amounting in one case to as much as $2.64 (11s. 0d.) per truck per hour.

At another steamship pier electric trucks are in use in unloading cargoes of wine, the vessels usually bringing 6,000 to 8,000 50-gallon barrels. Each sling hoists three barrels which, under the old method, were dropped on the pier and rolled several hundred feet to the bulkhead by laborers stationed a short distance apart. With the electric trucks the barrels are dropped on a small portable platform, from which six barrels are tipped on to each one of the trucks and carried to the stowing place. The seven trucks installed here handled an average of 547 barrels per hour, each barrel weighing about 500 pounds, at a saving of labor of $8 (£1 13s. 4d.) per hour.

At another pier coastwise steamers were discharged by the use of these trucks at an average saving in the cost of handling barrels, boxes and case goods of 10 cents (0s. 5d.) per ton. In this case freight was trucked from the hold of the vessel through side cargo ports and stowed on the pier. At another point, where the operation was similar to the last case mentioned, but where the labor rates are very low, the average saving compared with hand trucking made by each truck in the first six months' service was $600 (£125), or $100 (£20 16s. 8d.) per month per truck.

The electric truck has been used at various points for handling steamship freight with very large resulting economies. Where freight is trucked in and out of the ship through side ports, as is the case with a good many coastwise vessels, the trucks can run directly in and out of the vessel. Where freight is handled in and out of the vessel's hatches in sling loads by means of hoisting machinery, as is customary with the larger vessels, the trucks can deliver to or take from the slings a complete load. These loads can be made up on the truck when loading and be carried away at a single trip when unloading.

(Copyright by Underwood & Underwood, N. Y.)
Crumpled Bow of the Steamship *Nantucket* after Collision with the *Monroe*

Damage to the Nantucket

In the *Nantucket-Monroe* collision, which occurred on Jan. 30, resulting in the immediate sinking of the *Monroe*, with the loss of forty-one lives, the damage to the *Nantucket* was confined to the bow of the vessel. The above photograph gives some idea of the extent of this damage, as well as of the force with which the ships collided.

(Copyright by Underwood & Underwood, N. Y.)
Wreck of the Royal Mail Packet Company's Steamship *Cobequid* on Trinity Rock, Six Miles off Port Maitland, N. S.

McAndrew's Floating School

BY CAPTAIN C. A. McALLISTER *

CHAPTER XX

Examination Questions and Answers

Since the last lecture to his class McAndrew had been so busy with his regular duties that nearly a month had elapsed before another opportunity offered to give the boys in the Floating School further instruction. In the meantime the four young men had continued their studies, using such text-books as they had on hand for the purpose. It seems that Pierce, who was somewhat more ambitious than his shipmates, had, at about the time that the Chief commenced their instruction, enlisted as a student in one of the large correspondence schools and taken up its course in marine engineering. The text-books furnished with the course were very comprehensive, and Pierce had kindly loaned them to his fellow students, so that all had profited by studying them.

McAndrew commenced his remarks by saying, "We have now covered, in a somewhat brief manner, to be sure, nearly all the principal subjects necessary for an elementary understanding of marine engineering. It is now up to you to put in practice some of the things I have told you. To get your 'tickets' as assistant engineers is, of course, your ambition. The best way to prepare for your examination for a license is to work out some of the questions which have been asked by the steamboat inspectors. The existing laws in the United States concerning licenses are somewhat vague in regard to examinations, and I will quote you the following extracts from the statutes, which will be of interest to you:

" 'No person shall receive an original license as engineer or assistant engineer who has not served at least three years in the engineer's department of a steam vessel. * * *

" 'Any person who has served three years as apprentice to the machinist trade in a marine, stationary or locomotive engine works, and any person who has served for a period of not less than three years as a locomotive or stationary engineer, or any person graduated as a mechanical engineer from a duly recognized school of technology, may be licensed to serve as an engineer of steam vessels after having had not less than one year's experience in the engine department of steam vessels, a portion of which experience must have been obtained within the three years preceding his application, which fact must be verified by the certificate in writing of the licensed engineer or master under whom the applicant has served, said certificate to be filed with the application of the candidate; and no person shall receive license as above, except for special license, who is not able to determine the weight necessary to be placed on the lever of a safety valve (the diameter of valve, length of lever, distance from center of valve to fulcrum, weight of lever, and weight of valve and stem being known) to withstand any given pressure of steam in a boiler, or who is not able to figure and determine the strain brought on the braces of a boiler with a given pressure of steam, the position and distance apart of braces being known, such knowledge to be determined by an examination in writing, and the report of examination filed with the application in the office of the local inspectors, and no engineer or assistant engineer now holding a license shall have the grade of the same raised without possessing the above qualifications. No original license shall be granted any engineer or assistant engineer who cannot read and write and does not understand the plain rules of arithmetic.'

"So far as the letter of the law is concerned it would seem to be very easy for you to get a license, providing you can solve the two problems called for in the above qualification. But do not fool yourselves by thinking that you can get away with a ticket so easily; while the law on the subject is very old and not brought up to date, you will find that the examiners are very much alive to present conditions. While the law requires satisfactory answers to only those two questions, it does not prohibit further questioning by the inspectors, and if you ever pass your examinations you will find that you must be pretty well posted in about every subject connected with the business."

"Chief," inquired O'Rourke, "I see that you can get a ticket inside of a year if you are a graduate—how about graduates from our school?"

"I am afraid," replied McAndrew, "that our little school here would not score very heavily as a 'recognized school of technology'; but do not be alarmed about that. Where there is one licensed marine engineer who is graduated from a 'recognized school of technology' there are at least forty-nine who have graduated from the College of Practical Experience and Self-Help. This little Floating School of ours is simply a branch of that college.

"You will notice that the law requires that every candidate must understand the plain rules of arithmetic. I know that you all understand these rules, but I am not so sure that you all understand the plain rules of mensuration, or the measurements of area and volume. No one can pass the examination who does not understand these rules, so I will devote a few moments to explaining them to you.

Measurement of Areas and Volumes

"To find the area of any plain rectangular figure, that is, one having four square corners, you multiply the length by the breadth. Thus the side of a rectangular tank 8 feet long and 4 feet wide will contain $8 \times 4 = 32$ square feet.

"To find the volume of a rectangular tank we must multiply the length, breadth and depth together. Thus if the above tank is 4 feet in depth it will contain $8 \times 4 \times 4 = 128$ cubic feet.

"A circle is defined as a figure every point of whose circumference or boundary is equally distant from a point within called the center. You are familiar with how it is drawn with a pair of compasses. The diameter of a circle is the length of a line drawn across it and through its center. To find the length of the circumference, or distance around the circle, we multiply the diameter by the figures 3.1416. Thus if the diameter of a barrel is 2 feet, the circumference will be 2×3.1416, or 6.2832 feet.

"You will very often be required to find the area of a circle; the way to do it is to square the diameter; that is, multiply it by itself, and then multiply the quotient by the figures .7854. If you are told that a high-pressure cylinder is 30 inches in diameter, to find its area you first multiply 30×30, and get 900. Then $900 \times .7854 = 706.86$ square inches, the area.

"You must always remember those two 'constants,' as they are termed, 3.1416 for the circumference and .7854 for the area of a circle, as you will often have use for them when you do not have time to hunt them up in the text-books."

"I can remember them," said O'Rourke. "It's just as easy as remembering 4-11-44."

"Yes, and much more useful," said the instructor.

"It is also quite important for you to know how to find

* Engineer-in-chief, U. S. Revenue Cutter Service.

the volume and area of a cylinder. For example, if you are going to cover a tank with asbestos, you would want to know how to find the total area. A cylinder, you know, is a figure which if cut across perpendicular to its axis at any point between the top and bottom will be circular in section. Hence if we have a cylindrical tank 5 feet in diameter and 10 feet high, and wanted to know how much material was needed to cover it all over, we would first find the circumference of a circle 5 feet in diameter, which is 5 × 3.1416 = 15.708 feet. Multiply this by the height, 10 feet, and we have 10 × 15.708 = 157.08 square feet to cover all around the sides.

"How would you find the amount of covering for the ends, O'Rourke?"

"Multiply her by .7854," replied the young man.

"Multiply what?"

"Why, the 5 feet diameter, of course," confidently said O'Rourke.

"There's where you're wrong, as usual. I told you that in order to find the area of a circle you must square the diameter. So we have 5 × 5 = 25 and 25 × .7854 = 19.635 square feet as the area of one end. But there are two ends, so we must allow for twice that, or 39.27 square feet. This added to 157.08 gives us 196.35 square feet as the total surface of the tank.

"It is of equal importance for you to be able to find the volume of a cylinder, or how much it will hold if it is hollow, or how large it is if solid. For example, we want to know how many gallons of oil or water a tank like the above will hold. To do this we must first find the area of the circle, which from the above we know to be 19.635 square feet, and as it is simpler to calculate it in inches we multiply this number by 144, or 19.635 × 144 = 2827.4 square inches. Right here I want to warn you against a mistake that so many beginners fall into; that is, of multiplying feet by inches. Remember, feet must always be multiplied by feet and inches by inches, or your answer will be wrong. Hence the height or depth of this tank being 10 feet, we must use 10 × 12, or 120 inches, as the multiplier. Then we have 2827.4 × 120 = 339,288 cubic inches as the volume of the tank. There are 231 cubic inches in a gallon, so we divide the total number of cubic inches in the tank, 339,288 by 231, and we find in even numbers that the tank will contain 1,469 gallons.

"There are not many spherical surfaces around marine machinery, but it might be useful at some time for you to know how to find the volume and surface of a sphere or ball. This is defined as a solid bounded by a curved surface, every point of which is equally distant from a point within known as the center. Any line through the center and cutting the surface is the diameter. We will suppose that we have a ball float in the feed tank 12 inches in diameter, and want to know how much sheet copper it will take to make such a float. The rule is to square the diameter and multiply by our old friend 3.1416. Thus 12 × 12 = 144 and 144 × 3.1416 = 452.39 square inches as the surface of the ball. Now if we had a cast iron ball 6 inches in diameter hanging on a safety valve lever, and wanted to know its weight, we would first find its volume in cubic inches. To do this the rule is to cube the diameter; that is, multiply it by itself twice, and multiply that product by .5236. Thus in this case it would be 6 × 6 × 6 = 216, and 216 × .5236 = 113.1 cubic inches in the ball. Knowing that cast iron weighs .26 pound to the cubic inch we multiply 113.1 by .26, and find that the ball weighs 29.41 pounds."

"Chief, could you use that rule to find the weight of a highball?" inquired O'Rourke.

"From all I can hear of the subject highballs haven't much weight, as their general tendency is to make you light-headed," suggested McAndrew.

SAFETY VALVE PROBLEMS

"Now we are ready for the all-important safety valve problem, and I am particularly anxious to have you understand the principle upon which it is worked, rather than to learn some particular example, as is too often the case with beginners. When you come up for examination you will find that the conditions given you will be entirely different from any problem you may have worked out. The following is an outline sketch, which will enable you to follow out the principle involved.

"In Fig. 37, *O* represents the fulcrum, or point where the lever is hinged; *V* represents the valve; *N* the center of gravity of the lever; that is the point where, if the lever should be picked up in your hand, it would exactly balance and remain in a horizontal position. *M* represents the point where the weight *W* is located on the lever. The forces acting on the lever at *M* and *N* have a tendency to make it fall or rotate in a direction opposite to the hands of a watch. The weight of the valve and stem at *S* also has that tendency. The only upward force, or the only force tending to make the lever turn in the same direction as the hands of a watch, is the pressure of the steam on the valve *V*, operating on the lever at the point *S*. Now, safety valve levers are not supposed to be rotating in either direction, but to remain in equilibrium, hence the downward forces must be such as to balance the upward force, and the only force that can be adjusted to bring them all in equilibrium is that of the weight *W*. This can be done either by varying the weight itself or by moving it out or in from the fulcrum *O*.

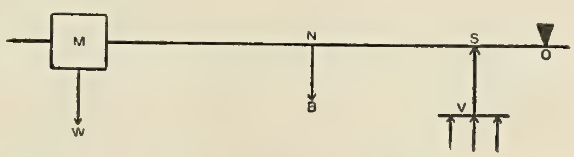


Fig. 37.—Safety Valve Problem

"The tendency to cause the lever to rotate about the fulcrum, with a ball of a given weight, varies with the distance the ball is from the fulcrum exactly as the principle of the levers, which I have explained to you before. To measure this tendency you multiply the weight by the distance from the fulcrum, and the product is known as the moment. Thus a weight of 1 pound, placed 4 feet from the fulcrum, would have a moment of 4 foot-pounds to cause rotation. Similarly, a weight of 4 pounds placed only 1 foot from the fulcrum would have the same moment of 4 foot-pounds. If the distances were given in inches we would speak of the moments in so many inch-pounds.

"To illustrate these principles, suppose in Fig. 37 we were given the following quantities:

Distance *OS* from fulcrum to center of valve 6 inches.
Weight of valve and stem 8 pounds.
Diameter of the safety valve 3 inches.
Steam pressure 50 pounds.
Weight of lever 10 pounds.
Center of gravity of lever 20 inches from fulcrum.
Distance of weight (*OM*) from fulcrum 30 inches.
Required, the size of the weight necessary to keep the valve in equilibrium when steam is at 50 pounds pressure.

"The upward tendency is represented by the pressure of the steam at *S*. A valve 3 inches in diameter has an area of 7.07 square inches; this, multiplied by 50, the pressure per square inch, gives us a total upward pressure of 353.5 pounds. But this is 6 inches from the fulcrum, so the moment will be 353.5 × 6 = 2,121.0 inch-pounds.

"All the other weights exert downward forces and tend to affect this upward pressure, so we will have the following to work against the 2,121 inch-pounds moment of the valve.

"Weight of valve and stem (8 pounds) multiplied by lever arms (6 inches) equals 48 inch-pounds.

"Weight of lever (10 pounds) multiplied by distance *OX* (20 inches) equals 200 inch-pounds.

"We do not yet know the size of the weight *W*, but we do know its distance from the fulcrum (30 inches), hence we add 48 and 200, and find the sum to be 248, and subtract it from 2,121 and find we have 1,873 inch-pounds to make the downward moments equal to the upward moments. This 1,873 is in inch-pounds, hence dividing it by 30 inches will give us 62.4 pounds as the size of the weight to maintain the balance.

"We will suppose that the weight (62.4) had been given us, and we were asked to ascertain what distance it should be located from the fulcrum in order to balance 50 pounds pressure on the valve. In this case we would have the same upward pressure from the valve, or 353.5 pounds, and the moment of 2,121.0 inch-pounds. The downward forces for the weights of the valve and stem and the lever will be represented by a total of 248 inch-pounds. As before, subtract this from 2,121 and we have 1,873 inch-pounds. Knowing the size of the weight in pounds (62.4) we divide it into 1,873. and find that the weight should be located 30 inches from the fulcrum in order to be in balance.

"Another way the problem might be given you is to find out what the steam pressure would be with all the conditions given as above. The downward pressures would be as before:

		Inch-Pounds
Valve and stem, 8 pounds × 6 inches	=	48
Lever, 10 pounds × 20 inches	=	200
Weight, 62.4 pounds × 30 inches	=	1,873
	Total.	2,121

"We know that the area of the valve is 7.07 square inches, and its lever arm, or distance from the fulcrum, is 6 inches, so we have 7.07 × 6 = 42.42. As there is only the one force acting upward we divide 2,121 by 42.42, and find that a pressure of 50 pounds can be carried with the weight set in the position given.

How to Figure the Stresses on Boiler Braces

"The next problem we will take up is the one required by law: 'to figure and determine the stresses brought on the braces of a boiler with a given pressure of steam, the position and distance apart of braces being known.'

"This is very simple, as it only involves multiplication. Thus if the braces are spaced 12 inches apart each way, and the steam pressure is 160 pounds per square inch, we multiply 12 by 12, and find that there are 144 square inches to be supported, and 144 × 160 = 23,040 pounds stress which is brought on one brace. Similarly, if the braces are spaced 14 inches apart horizontally and 10 inches vertically, and the steam pressure is 160 pounds per square inch, we would multiply 14 by 10, and find that there is an area of 140 square inches to be supported by one brace, and 140 × 160 would give us 22,400 pounds, or an even 10 tons, as the total stress on one brace.

"The inspectors, however, do not confine themselves to this simple form of the problem, and you are liable to get one like the above, with the addition that they would ask you the safe diameter of the brace. To perform this we must know the United States rules as to the safe working load per square inch of section. These rules give allowances of 6,000 pounds per square inch of section for iron; above 5 square inches sectional area if steel is used and regularly inspected an allowance of 8,000 pounds per square inch is made; braces above 1¼ inches diameter are not allowed to exceed 9,000 pounds per square inch of section if such stays are not forged or welded.

"You might get a question similar to the following: What diameter of bracing should be used to support a flat surface 12 inches by 12 inches, using steam at 200 pounds pressure? The solution would be 12 × 12 = 144, and 144 × 200 = 28,800 pounds to be supported; 28,800 ÷ 9,000 = 3.2 square inches. Looking at a table of areas we would find that a stay having a diameter of 2 1/16 inches has an area of 3.341 square inches, which is the nearest area to the one we know to be necessary. Very likely these braces would be made 2⅛ inches in diameter, as that would be the nearest commercial size obtainable.

Allowable Working Pressure on a Boiler

"Possibly you will be asked how to find what pressure will be allowable on a Scotch boiler, knowing the thickness of shell, the diameter of the boiler, tensile strength of plate, etc.

"The United States Government rule is to multiply one-sixth of the lowest tensile strength in pounds by the thickness in inches, and divide by one-half the diameter, also in inches; 20 percentum is to be added if double riveting is used for the horizontal seams, which, of course, would be used these days; in fact, the seams would probably be triple-riveted, but the rule makes no allowance for that.

"For example, if we had a boiler 15 feet in diameter, made of steel plates, the lowest tensile strength of which was 60,000 pounds per square inch, and the shell was 1½ inches in thickness, and we wanted to find what presure would be allowed by the inspectors, we would proceed as follows:

15 feet × 12 = 180 inches diameter.
One-half of 180 = 90 inches.
One-sixth of the lowest tensile strength (60,000 pounds) = 10,000 pounds.
1½ inches = 1.5 inches.
10,000 × 1.5 = 15,000.
15,000 ÷ 90 = 166.6 pounds.

"As double riveting allowances must be made, we add 20 percent of this and have 166.6 + 33.4 = 200 pounds pressure allowable on the boiler."

"Chief," said Pierce, "suppose we wanted to find out what thickness to make this boiler shell, and we knew the size and pressure we wanted to carry?"

"We would simply reverse the operation," replied McAndrew. "In other words, multiply the radius in inches by the pressure in pounds and divide by one-sixth the tensile strength. Thus 90 × 200 = 18,000; 18,000 ÷ 15,000 = 1.2 inches thick. But for double riveting an allowance of 20 percent additional is made, and 1.2 is only 80 percent (100 — 20) of the thickness allowance. As 80 percent is 1.2, 100 percent will be 1.5 inches, the thickness which we will have to make the boiler shell in order to withstand the pressure required and conform to the rules.

"Strange to say, all the problems required by law to be given candidates for engineers' licenses in this country relate to boilers. These laws were passed in the early days of steam navigation, and I presume that the legislators in those days thought that if a man understood boilers thoroughly he could manage somehow to run the engines. Fortunately for the good of the service the inspectors ask questions concerning nearly all parts of the steam machinery, so it is well to be prepared in a general way."

(*To be concluded.*)

Launch of the Britannic.—The new White Star liner *Britannic*, a 48,000-ton triple-screw steamer, 885 feet long over all, was successfully launched at the Harland & Wolff shipyard, Belfast, on February 26. Propulsion of the vessel is by combination machinery.

Lloyd's Summary of World's Shipbuilding

Comprehensive Returns from the Ship and Engine Building Firms of All Maritime Nations Show a Record Output for 1913

According to the annual returns of Lloyd's Register of British and Foreign Shipping, just published, which take into account only vessels of 100 tons gross and over which were launched during the year, the total output of the world during 1913 appears to have been 4,009,791 tons. The merchant tonnage amounted to 3,332,882 tons and the warship tonnage to 676,909 tons. The merchant tonnage shows an increase of about 431,000 tons over the returns for 1912. According to the latest advices from Lloyd's Register, the gross tonnage of vessels of all nationalities totally lost, broken up, etc., during the twelve months amounts to about 682,000 tons gross. The net increase of the world's mercantile tonnage at the end of 1913 is, therefore, about 2,651,000 tons. Steam tonnage has been increased by about 2,690,000 tons, while sailing tonnage has been reduced by 39,000 tons. The warship tonnage, amounting to about 677,000 tons displacement, exceeds the tonnage launched during 1912 by about 142,000 tons, and is the largest reached, with the exception of 1911, when the output was 92,000 tons higher.

SHIPBUILDING IN THE UNITED KINGDOM

During 1913, exclusive of warships, 688 vessels of 1,932,153 tons gross have been launched in the United Kingdom. The warships launched at both Government and private yards amount to 49 of 271,376 tons displacement. The total output of the United Kingdom for the year has, therefore, been 737 vessels of 2,203,529 tons. The output of mercantile tonnage in the United Kingdom during 1913 shows an increase of 193,639 tons on that of last year, and is the highest ever reached. As regards war vessels, the total is nearly 80,000 tons more than in 1912. Practically the whole of the tonnage launched has been built of steel, and over 99 percent is composed of steam tonnage.

Size and Speed of Vessels—The number of large steamers launched in the United Kingdom during 1913 has greatly exceeded the average of recent years. During the five years, 1908-12, 205 vessels of 6,000 tons and upwards were launched in the United Kingdom, showing a yearly average of 41 vessels; and of the total number, 57 were of 10,000 tons and upwards.

The returns for 1913 show that 84 vessels of 6,000 tons and above were launched. Of these, 21 were over 10,000 tons each, the largest being the Cunard liner *Aquitania*, of 47,000 tons, and the Allan line steamers *Alsatian* and *Calgarian*, 18,485 tons each. The following are the other vessels of 13,000 tons and upwards, viz.:

	Tons gross.		Tons gross.
Andes	15,620	*Tubantia*	14,055
Alcantara	15,600	*Gelria*	13,868
Orduna	15,600	*Alaunia*	13,450
Ulysses	14,491	*Andania*	13,405

Of the vessels launched in the United Kingdom 16 are capable of a speed of 16 knots and above. The fastest of these are the turbine vessel *Aquitania* and two other turbine steamers intended for service in the Irish Sea and for the English Channel, respectively, the three designed for a speed of over 20 knots.

Vessels Fitted With Turbines and Internal Combustion Engines—Four steamships, viz.: *Andes*, 15,620 tons; *Alcantara*, 15,600 tons; *Orduna*, 15,600 tons, and *Katoomba*, 9,424 tons, have been fitted with a combination of turbines and reciprocating engines. During 1913, including the vessels mentioned in the preceding paragraph, seven steamers were launched, with a total tonnage of 88,927 tons, which will have turbines only. The launches for the year also include three vessels of a total tonnage of 8,494 tons, with internal combustion engines, the largest being the *Arum*, of about 3,550 tons. In addition, 14 small vessels of under 300 tons each, also fitted with motors, were launched during the year.

Other Special Types—Of steamers building on the Isherwood system of longitudinal framing, 47 were launched during 1913, with a gross total tonnage of 276,233 tons. Including 31 of these vessels with a tonnage of 199,750 tons, there were launched during the past year 43 steamers of 237,548 tons for the carriage of oil in bulk. The returns also include seven vessels of other special constructional design; 117 steam trawlers and other fishing vessels; 25 tugs, besides a large number of dredgers, barges and other vessels designed for channel, river and other special services.

Output of Leading Ports.—The Glasgow district occupies the first place among the shipbuilding centers of the country, showing an output of 415,044 tons. Then follow Newcastle, 366,331 tons; Sunderland, 299,964 tons; Greenock, 269,743 tons; Middlesbro', 154,743 tons; Hartlepool, 153,071 tons, and Belfast, 129,081 tons. In warship tonnage Glasgow also leads with 66,803 tons displacement, closely followed by Newcastle, 65,737 tons, and Barrow, 54,400 tons.

Progress of Shipbuilding During the Year—As regards the movement of the shipbuilding industry during the course of 1913, Lloyd's Register returns show that at the opening of the year, irrespective of warships, 1,970,065 tons were being built in the United Kingdom. The returns for the March quarter indicated an increase of about 94,000 tons in the work in hand, thus recording the highest total ever reached. Since then a steady decline has taken place. The June returns showed a decrease of about 60,000 tons, and the September returns a further decrease of 16,000 tons. The amount of tonnage under construction at the end of December, although 107,000 tons less than the record figures of last March, is within 13,900 tons of the total building at the end of 1912. The total warship tonnage under construction in the country is now 604,801 tons displacement, as compared with 496,875 tons twelve months ago.

SHIPBUILDING IN OTHER COUNTRIES

Outside the United Kingdom there have been launched during the year 1,193 vessels of 1,806,262 tons, divided as follows: Merchant and other vessels, 1,062 of 1,400,729 tons; warships, 131 of 405,533 tons displacement. The figures for merchant tonnage show the very large increase of over 237,000 tons, as compared with those for 1912, and constitute a record. The leading places are held by Germany, 465,226 tons; the United States, 276,448 tons; France, 176,095 tons, and Holland, 104,296 tons.

The largest vessel of the year was the turbine steamship *Vaterland*, of about 56,000 tons. During 1913 thirteen vessels of over 3,700 tons each, to be fitted with internal combustion engines, were launched. Their aggregate tonnage amounted to about 66,800 tons. The figures for the year include six steamers of a total tonnage of 85,950 tons, to be fitted with turbines, and five 67,361 tons, which will have a combination of reciprocating engines and turbines. The output for the year also includes 27 oil-carrying steamers of a total tonnage of 129,400 tons.

The total output of war vessels shows an increase of about 63,000 tons displacement on the figures for the preceding year.

Germany—The returns show an increase of 90,000 tons in the shipbuilding output as compared with last year, and the figures are easily the highest on record. The three largest were the Hamburg-Amerikan liner *Vaterland,* of about 56,000 tons gross, launched at Hamburg; the steamship *Columbus,* 35,000 tons, launched at Danzig for the Norddeutscher Lloyd Company, and the turbine vessel *Admiral von Tirpitz,* 21,600 tons, launched at Stettin. The total output includes four vessels of 26,000 tons fitted with internal combustion engines, the largest being the oil carrier *Wilhelm A. Riedemann,* 9,800 tons.

United States—The tonnage reported from the United States is nearly 8,000 tons less than that of the previous year. This is the only country that shows a decrease, which is entirely accounted for by the fact that, notwithstanding a larger output on the coast, the tonnage launched on the Great Lakes is nearly 42,000 tons less than that which was turned out in 1912.

France—The present returns show an increase of over 65,000 tons as compared with the tonnage launched during 1912.

TABLE I.—SUMMARY OF THE WORLD'S SHIPBUILDING OUTPUT FOR THE YEARS 1911, 1912 AND 1913

Where Built.	Description.	1911.		1912.		1913.	
		No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
United Kingdom	Merchant Vessels.....	772	1,803,844	712	1,738,514	688	1,932,153
	Warships.....	50	230,786	30	191,737	49	271,376
	Total.......	822	2,034,630	742	1,930,251	737	2,203,529
Other Countries	Merchant Vessels.....	827	846,296	1,007	1,163,255	1,062	1,400,729
	Warships.....	119	538,083	144	342,892	131	405,533
	Total.......	946	1,384,379	1,151	1,506,147	1,193	1,806,262
World's Output..........		1,768	3,419,009	1,893	3,436,398	1,930	4,009,791

They are the highest for the last 11 years. The figures include two steamers, the *Gallia,* 14,966 tons, and *Lutetia,* 14,582 tons, launched, respectively, at La Seyne and St. Nazaire, and both to be fitted with turbines and reciprocating engines.

Holland—The total tonnage launched in Holland during the past year is the highest ever recorded in the society's returns for that country. This total does not include vessels known to be exclusively intended for river navigation. From information to hand it appears that the tonnage of steamboats, barges and other river vessels launched during 1913 amounts to more than 126,000 tons; so that the total output, including such craft, would appear to reach over 230,000 tons.

Japan—The tonnage launched during the year has only been exceeded once, in 1907, and then only by 1,590 tons. It comprises the steamers *Kashima Maru,* 10,589 tons; the *Katori Maru,* 10,513 tons, fitted with turbines and reciprocating engines, and one of 9,534 tons.

Austria-Hungary—The present figures, 61,757 tons, are the most favorable ever returned for this country, beating the previous record year (1912) by no less than 23,000 tons. They are composed almost entirely of vessels of between 5,000 and 8,000 tons.

Norway—The returns for the year show the output to be 50,637 tons, which is about the same as that for the previous year. As in other years, the total is practically composed of small vessels.

Italy—The output for the year amounts to 50,356 tons, which is double that of last year, and the highest since 1905. There are five vessels of from 5,500 to 6,500 tons included in the returns.

British Colonies—The output of the British Colonies (48,339 tons) is the highest on record. It includes two large steamers, both built on the North American Lakes, one of 6,900 tons, and the other, the *James Carruthers,* 7,862 tons, which was lost during the violent storm which struck the Great Lakes in November.

Denmark—In this country also the record output has been reached. The figures, 40,932 tons, are nearly 15,000 tons higher than last year. Included in this total are four vessels of between 4,600 and 5,300 tons, two of which are to be fitted with Diesel engines. Two other smaller vessels were also launched to be similarly fitted.

TABLE II.—TABLE SHOWING THE TONNAGE OF VESSELS OF 100 GROSS AND UPWARDS (EXCLUDING WARSHIPS) LAUNCHED IN THE VARIOUS COUNTRIES OF THE WORLD DURING THE LAST DECADE

Year.	United Kingdom.	British Colonies	Hungary	Denmark	France.	Germany.	Holland.	Italy.	Japan.	Norway.	United States.	Other C'ntries.	Totals.
1904	1,205,162	30,965	16,645	15,859	81,245	202,197	55,636	30,016	32,969	50,469	238,518	28,254	1,987,935
1905	1,623,168	10,798	16,402	17,557	73,124	255,423	44,135	61,629	31,725	52,580	302,827	25,554	2,514,922
1906	1,828,343	26,042	18,590	24,712	35,214	318,230	66,809	30,560	42,489	60,774	441,087	26,913	2,919,763
1907	1,607,890	46,443	8,717	28,819	61,635	275,003	68,623	44,666	66,254	57,556	474,675	37,807	2,778,088
1908	929,669	34,181	23,502	19,172	83,429	207,777	58,604	26,864	59,725	52,839	304,543	32,981	1,833,286
1909	991,066	7,461	25,006	7,508	42,197	128,696	59,106	31,217	52,319	28,601	209,604	19,276	1,602,057
1910	1,143,169	26,343	14,304	12,154	80,751	159,303	70,945	23,019	30,215	36,931	331,318	29,401	1,957,853
1911	1,803,844	19,662	37,836	18,689	125,472	255,532	93,050	17,401	44,359	35,435	171,569	27,291	2,650,140
1912	1,738,514	34,790	38,821	26,103	110,734	375,317	99,439	25,196	57,755	50,255	284,223	60,622	2,901,769
1913	1,932,153	48,339	61,757	40,932	176,095	465,226	104,296	50,356	64,664	50,637	276,448	61,979	3,332,882

TABLE III.—TABLE SHOWING THE NUMBER AND DISPLACEMENT OF WARSHIPS OF 100 TONS AND UPWARDS LAUNCHED FOR THE VARIOUS NAVIES DURING THE LAST DECADE

Year	British.		United States.		Austro-Hungarian.		French.		German.		Italian.		Japanese.		Russian.		Other Navies.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.	No.	Tons.
1904	33	126,375	14	170,185	3	11,480	9	43,600	11	44,970	4	25,932	4	608	5	1,750	19	10,106	102	435,006
1905	23	96,505	7	98,200	3	11,020	7	28,611	6	36,487	10	14,490	17	50,633	37	15,721	8	11,544	118	363,211
1906	23	85,700	5	45,443	10	2,760	6	15,183	17	62,678	14	3,039	24	41,277	19	82,204	30	24,688	148	362,972
1907	33	133,405	5	11,590	7	1,594	17	33,594	17	14,800	12	25,154	10	57,200	17	35,317	24	8,557	142	321,211
1908	26	49,560	8	52,850	8	16,153	22	21,600	16	97,660	5	29,400	4	2,245	11	8,800	27	31,421	127	309,689
1909	35	98,790	15	48,639	23	22,217	19	95,740	27	99,116	8	2,088	1	375	2	1,246	21	36,264	151	404,475
1910	43	133,525	13	30,287	8	14,993	12	24,063	21	49,024	4	19,374	3	23,100	..	....	18	16,488	122	310,854
1911	41	221,430	13	57,526	2	20,269	15	53,995	28	128,340	15	75,018	6	37,071	5	93,260	44	81,960	169	768,869
1912	28	163,087	15	62,673	7	49,361	21	55,965	30	99,810	35	14,939	4	56,035	1	492	33	32,267	174	534,629
1913	42	187,566	15	10,752	11	9,922	12	75,401	25	148,100	22	52,628	3	55,490	7	27,564	43	109,486	180	676,909

Work in Hand at the End of 1913

At the end of December there were under construction in the United Kingdom, including a number of vessels already launched, but not completed, 73 vessels of between 6,000 and 10,000 tons; 23 of between 10,000 and 15,000 tons; 9 of between 15,000 and 20,000 tons; 2 of between 20,000 and 40,000 tons and 2 of over 45,000 tons each. The total tonnage under construction was 1,956,606 tons.

Outside of the United Kingdom, at the end of December there was under construction throughout the world a total of 1,374,537 gross tons. Germany occupies the first place with 544,682 tons, and next come France with 229,020 tons, the United States with 147,597 tons, and Holland with 126,867 tons. Of vessels the construction of which has been actually commenced, but which were not yet launched, there were 62 steamers of between 5,000 and 10,000 tons, 20 of which are building in Germany; 15 steamers of between 10,000 and 15,000 tons; 3 steamers between 15,000 and 20,000 tons, and 4 steamers of over 20,000 tons (3 in Germany and 1 in France), the largest being of about 56,000 tons, building in Germany, and one of 30,000 tons building in France. These figures include 4 vessels aggregating 104,000 tons, to be fitted with turbines; 5 of 86,500 tons, with a combination of turbines and reciprocating engines, and 4 of 21,200 tons, to be fitted with internal combustion engines. There are also 6 other vessels building on the Continent of between 1,000 and 4,000 tons each to be fitted with this latter type of engine.

New York Motor Boat Show

At the tenth annual National Motor Boat Show, held in Madison Square Garden, New York City, from Jan. 31 to Feb. 7, the high standard of excellence established at previous exhibitions was not only fully sustained but in many respects surpassed. The Garden itself, decorated from floor to ceiling in Venetian effect, presented a scene which was both pleasing and entirely in keeping with the character of the exhibition. On the main floor were the exhibits of boats and engines, while in the gallery could be found practically every type of accessory necessary to complete the equipment of the most elaborate motor craft. Ranging from high-speed boats and cruisers to runabouts and flying boats, the exhibits included splendid examples of the latest developments in practically every type of motor boat. Unique among the familiar pleasure boats were two exhibits of motor lifeboats, both of which were distinct innovations. The first, which was shown by the Welin Marine Equipment Company, Long Island City, was the Lundin decked motor lifeboat built along the lines described in our June, 1913, issue. The hull is 30 feet long by 10 feet beam, built of steel on the double-hull system, with special self-bailing arrangements, and is practically non-capsizable. Power is furnished by a 20-24 horsepower Standard motor, with the propeller running in a tunnel fully protected from damage. The outfit includes wireless apparatus, a life-saving gun, and reels of rope at both bow and stern for establishing communication with other craft for towing or rescue work. The other motor lifeboat exhibited was designed by Capt. McLellan and built by the Holmes Motor Company. Its design follows the lines of the regulation Government 36-foot lifeboat. The beam is 8 feet 6 inches and the draft 2 feet 8 inches. It is double ended, with turtleback decks forward and aft, and a large roomy trunk cabin and self-bailing cockpit amidships. The engine, a 20-25 horsepower Holmes long-stroke motor, is located in the after cabin. Among the engines exhibited, which ranged from the smallest to the largest gasolene (petrol) motors, special interest was attracted to five motors of the Diesel type. One of these exhibited by the New London Ship & Engine Company, Groton, Conn., was a 6-cylinder, 4-cycle, 180-horsepower Diesel motor, with cylinders 9 inches bore and 12½ inches stroke, developing its power at 350 revolutions per minute. The engine weighs 15,000 pounds, exclusive of the reverse gear. Another Diesel engine, which is a new-comer on the market, was exhibited by the James Craig Engine & Machine Works, Jersey City, N. J. This is a self-starting and reversing 6-cylinder, 4-cycle, 200-horsepower engine, with a bore of 9½ inches and 11 inches stroke. A distinctive feature of this engine is the provision of an auxiliary exhaust valve cut in the cylinder walls at the bottom of the piston stroke. A single high-pressure fuel pump feeds all the cylinders through a special distributor. The Fulton Manufacturing Company, Erie, Pa., exhibited a 3-cylinder Diesel engine of 8 inches bore and 9 inches stroke, weighing complete 5,000 pounds and rated to develop 50 horsepower at 400 revolutions per minute. Another new-comer in the Diesel engine field is the Gas Engine & Power Company and Chas. L. Seabury & Company, Cons., Morris Heights, New York City, who exhibited a 175-horsepower, 4-cylinder, 2-cycle Diesel crude-oil motor. The cylinders are 9 inches bore and 12 inches stroke. The engine weighs 16,500 pounds, is self-starting and reversible and develops its power at 350 revolutions per minute. Besides the Diesel engines, a sigle-cylinder, 2-cycle motor of the semi-Diesel type was exhibited by W. R. Haynie, New York City. This motor was a 15-horsepower Bolinder's crude-oil engine of the heavy duty type, fitted with a powerful reverse gear.

In addition to the heavy oil engines, a complete marine producer gas outfit was exhibited by the Wolverine Motor Works, Bridgeport, Conn. The producer was of the Galusha type, adapted to burn coal, coke or charcoal, and was connected to a 3-cylinder, 36-horsepower Wolverine motor, especially arranged for using producer gas.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		Nov. 1.	Feb. 1.
New York	28,000	21	Navy Yard, New York	92.0	96.4
Texas	28,000	21	Newport News Shipb'g	96.0	98.3
Nevada	28,000	20½	Fore River Shipb'g Co.	49.2	55.2
Oklahoma	28,000	20½	New York Shipb'g Co.	48.7	60.8
Pennsylvania	31,400	21	Newport News Shipb'g	11.8	17.0
No. 39	31,400	21	Navy Yard, New York	00.0	4.7

TORPEDO BOAT DESTROYERS

Downes	1,010	29	New York Shipb'g	81.7	93.7
Aylwin	1,010	29	Wm. Cramp & Sons	97.4	100.0
Parker	1,010	29	Wm. Cramp & Sons	95.2	100.0
Benham	1,010	29	Wm. Cramp & Sons	93.0	100.0
Balch	1,010	29	Wm. Cramp & Sons	92.6	92.6
O'Brien	1,050	29	Wm. Cramp & Sons	14.9	42.1
Nicholson	1,050	29	Wm. Cramp & Sons	13.6	42.1
Winslow	1,050	29	Wm. Cramp & Sons	14.2	40.3
McDougal	1,050	29	Bath Iron Works	34.3	66.6
Cushing	1,050	29	Fore River Shipb'g	21.3	32.0
Ericsson	1,050	29	New York Shipb'g	15.1	40.9
No. 57	1,090	29½	Fore River Shipb'g Co.	00.0	6.8
No. 58	1,090	29½	Wm. Cramp & Sons	00.0	2.6
No. 59	1,090	29½	Wm. Cramp & Sons	00.0	2.5
No. 60	1,090	29½	Bath Iron Works	00.0	7.2
No. 61	1,090	29½	New York Shipb'g Co.	00.0	8.9
No. 62	1,090	29½	New York Shipb'g Co.	00.0	8.9

SUBMARINE TORPEDO BOATS

G-4	....	....	Wm. Cramp & Sons	96.4	96.4
G-2	....	....	Newport News Shipb'g Co.	89.7	89.7
H-1	....	....	Union Iron Works	97.9	100.0
H-2	....	....	Union Iron Works	97.9	100.0
H-3	....	....	Seattle Con. & D. D. Co.	98.0	100.0
G-3	....	....	Lake T. B. Co.	74.2	80.3
K-1	....	....	Fore River Shipb'g Co.	94.0	99.2
K-2	....	....	Fore River Shipb'g Co.	91.8	100.0
K-3	....	....	Union Iron Works	88.6	91.7
K-4	....	....	Seattle Con. & D. D. Co.	88.0	89.4
K-5	....	....	Fore River Shipb'g Co.	79.3	88.9
K-6	....	....	Fore River Shipb'g Co.	78.3	88.7
K-7	....	....	Union Iron Works	78.5	83.6
K-8	....	....	Union Iron Works	76.4	83.0
L-1	....	....	Fore River Shipb'g Co.	13.0	22.8
L-2	....	....	Fore River Shipb'g Co.	13.0	22.5
L-3	....	....	Fore River Shipb'g Co.	13.0	22.5
L-4	....	....	Fore River Shipb'g Co.	13.0	22.4
L-5	....	....	Lake T. B. Co.	7.4	7.4
M-1	....	....	Fore River Shipb'g Co.	9.7	14.1

COLLIERS

Kanawha	14,000	14	Navy Yard, Mare Island	9.4	31.5
Maumee	14,000	14	Navy Yard, Mare Island	5.3	17.5

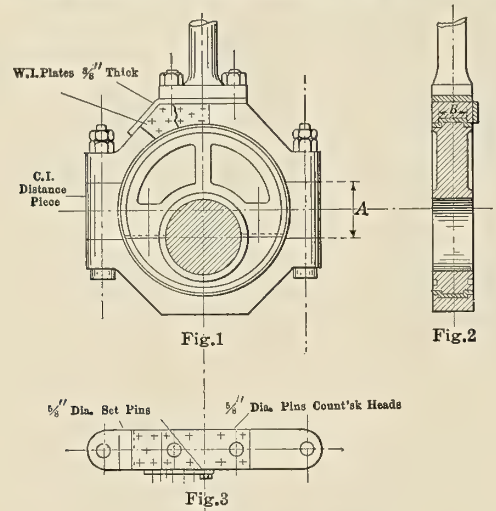
Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Repairs to Broken Eccentric Strap

I was in the steamship ——— when the following breakdown happened. We had crossed the Western Ocean and were within a few hours' sail of our discharging port on the Continent, when the intermediate-pressure ahead eccentric strap broke. It was a cast iron strap, lined with white metal, with distance pieces of cast iron between the top and bottom halves. The valve gear was of the Stephenson link-motion type, with open rods.

The break was right through the center of the stud hole, as shown on Fig. 1. When it occurred the engines were stopped and the broken strap taken off, to be replaced by the astern one, a little adjustment with liners bringing the gear right with the trammel marks on the spindle at the guide bracket. The astern rod was disconnected, and the weight of



Broken Eccentric Strap

the unsupported end of the link was taken up with rope tackle. When the engines were started the tackle was found unnecessary, and so was dispensed with. After a delay of about five hours we were able to proceed to port without any further mishap; of course, being minus the astern rod and strap the engines could not go astern, so the assistance of a tug was required to bring us alongside.

The repairs executed in this port were as follows: The white metal in the broken strap was dressed up, then two wrought iron plates, 3/8 inch thick, were made; one to cover the break on the top and front and the other on the side, as shown in Figs. 1 and 3. These plates were fixed by 5/8-inch diameter screwed pins; those under the butt of the rod having countersunk heads.

As the break was "clean," there was no difficulty in "knitting" the two parts together or in replacing the stud. The two halves were then bolted on the astern eccentric, and the distance *A,* Fig. 1, taken with inside callipers. When this size was compared to the length of the distance pieces it was found necessary to cut 3/8 inch off of them. When this was done, the astern rod was connected up and the valve set. After closing up, the engines were turned both ways satisfactorily. We left for London, and arrived there without having had any trouble on the passage across, the repaired eccentric successfully standing the many maneuvers going up the river.

The cause of the mishap, in my opinion, was due to the eccentric running slack. This was occasioned by the white metal breaking off round the edge, part of which probably found its way into the center of the bearing surface, hence the wearing down of the strap.

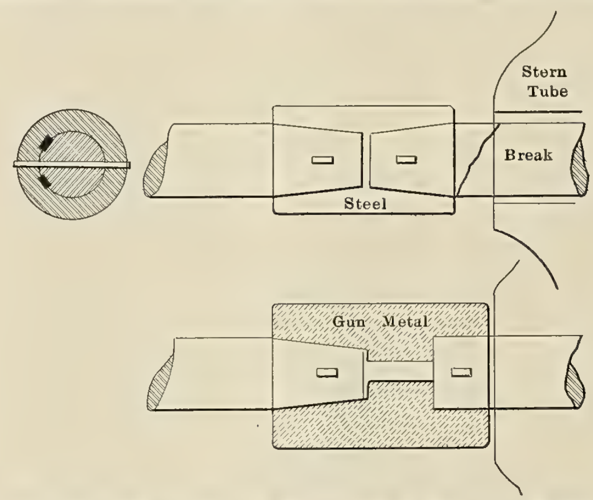
When we were repairing the strap, I observed that the white metal was fixed in, as shown in Fig. 2. The recess *B* in the strap, I think, was too broad, leaving but little surface to support the strip of white metal at the edge. The nuts fixing the butt end of the eccentric rod were found to have slackened back, which may account for the break happening where it did.

M. C.

Glasgow.

Broken Propeller Shaft

The starboard propeller shaft of a United States gunboat cruising along the South American coast carried away abaft the stern tube. The broken shaft worked out before the ship was stopped, until the sleeve coupling on the shaft brought up on the strut and prevented the loss of the propeller. A line with a noose-end was put over the stern and slipped over the propeller blade and made fast on deck, when the vessel went ahead, steaming five days with the port engine alone to the next port. Upon arrival the vessel was docked, and examination disclosed that the fracture occurred at the forward



Gun Metal Sleeve Cast to Replace Steel Sleeve on Broken Shaft

end of a sleeve coupling used to join two sections of the shaft and close to the end of the stern tube.

Repairs were made without removing the shaft from the ship. The steel sleeve coupling was removed. The shaft was uncoupled in the engine room and shoved outboard about 9 inches, a distance piece 9 inches thick being then fitted between the flanges and longer bolts substituted. A gunmetal sleeve was cast, much larger in diameter than the cast steel sleeve which it replaced, and bored to fit the taper on the after section of the shaft and bored straight and pressed on the forward section, using as before two feathers and one key in each end to secure it to the shaft. The break was so close to the end of the stern that it was necessary to move the shaft outboard 9 inches to obtain bearing surface for the new coupling, the remaining distance between the ends of the shaft being made up by the coupling. The shaft was of nickel-steel, tough and hard to work, and to dress off the jagged end,

cut the keyways and fit the keys and coupling with the shaft in place in the ship with hand tools required skill and patience. J. E. Cleary.

Philadelphia, Pa.

How an Engineer Saved His Ship

Marine engineers perform deeds of heroism in the ordinary routine of their duties which, if they were known, would win the plaudits of an admiring public. Unlike the railroad engineer, whose many deeds of heroism are all necessarily performed in the limelight, the marine engineer works below decks, out of sight, and at sea, where comparatively few persons come in contact with him, so that, while both classes of engineers do their duty without any hope or expectation of fee or reward, the marine engineer seldom gets credit for the many deeds of valor he performs.

During a heavy gale the tail shaft of a transatlantic steamship broke obliquely in the stern tube, so that one section of the break rode on top of the other section as the propeller revolved in the seaway, breaking the stern tube and tearing the flange on the end from the watertight bulkhead in the after end of the shaft tunnel. The water poured into the tunnel in torrents through the bulkhead and it immediately became apparent that a serious condition of affairs existed.

The watertight door in the engine room bulkhead at the forward end of the tunnel, of course, could have been closed, but the chief engineer was sure that this would not do, as he had grave doubts as to the ability of the tunnel casing to withstand the pressure of the water when it filled. He knew that if the tunnel casing gave way the ship was doomed, for the reason that when the after hold filled the engine room bulkhead would go. In the days when this ship was built watertight bulkheads were a delusion and a snare.

He was reasonably sure that the after bulkhead would hold, as it was of small area and more substantially built and securely fastened to the frames of the ship than the larger engine-room bulkhead, so he decided that the proper thing to do was to get the stern tube back in place, thus stopping the leak.

Most engineers can imagine what a task this was, working in such cramped quarters, water pouring in around the tube, which was in constant motion with the working of the shaft, with only such appliances as were to be found aboard a ship to work with, and time so limited that minutes were precious. Little time was wasted in discussing the question as to what was the best thing to do. Not a man in the engine-room force faltered or questioned the advisability of the chief engineer's decision.

Several pieces of 6-inch by 6-inch scantling, together with blocking that was kept in the engine-room for various purposes and some screw-jacks from the store room, were hastily secured and, led by the courageous little Scotch chief, the engineers started back through the long shaft tunnel for the scene of operations.

By the time they had reached the after end the water was up to their knees and rising rapidly in spite of the fact that all of the pumps that could be used were working on the after compartment.

It was a heartrending task that confronted these heroic men. The propeller was threshing around in the seaway, causing the end of the tube in the shaft tunnel to jump around pretty lively; the ship was pitching and tossing in the heavy sea and every piece of wooden blocking had to be firmly held on to. One piece that slipped from the hands of one of the men narrowly escaped dashing the brains out of another man as it rushed by his head, floating on top of the water while he stooped under the shaft.

Several attempts were made to get the ends of the pieces of scantling against the flange on the end of the tube, the intention being to block between the other ends of the scantling and the foundation of the after spring bearing and force the tube back in place with the screw-jacks. This sounds simple enough, but almost any mechanic can see what a troublesome task this would be alongside of a dock in smooth water, holding the scantling in place, placing the blocking and setting the screw-jacks, but under the conditions then existing it seemed as if it would be impossible to do it. About the time the blocking would be adjusted the tube would jump and throw the ends of the scantling off, or just as the screw-jacks were to be put in place a hand would be taken off the blocking, which was entirely under water, and it would all float adrift and would again have to be replaced.

However, these men were of the type who never say die—most marine engineers are—and they kept at it. During a momentary lull, such as is customary even in the heaviest sea, the scantling and blocking were held in place long enough to get the screw-jacks in and a strain taken on them, and then the rest was easy. The screw-jacks were rapidly set up, although the men operating them had to go entirely under water to do this, and when the flange had been forced back in place on the bulkhead the water had risen so that the heads of the men were just out of it.

It required only a few minutes for the pumps to clear the shaft tunnel when the opening was closed, and then the tube was more securely shored and braced and the engineers were enabled to change their wet clothing and get a respite from their arduous labors. There was no real rest for them even then. The shores had to be constantly watched and, as they loosened up with the vibrations caused by the threshing around of the broken shaft, they had to be tightened up and sometimes replaced, although, fortunately, as all of them would not get out of place at the same time, the tube was not again forced out of its position.

Another ship belonging to the same company happened to come near enough to see the signals of distress (this was before the days of wireless telegraphy, with its S. O. S. call for assistance so promptly answered by other ships which otherwise would know nothing of the trouble), and after as pretty a piece of maneuvering as had ever been seen at sea, passed a line and towed the disabled ship into port.

The writer had the opportunity of examining this, to him, splendid feat of marine engineering on the arrival of the ship in Antwerp, where she was taken for repairs, and the one thing that impressed him most, aside from the difficulty of the task as performed, was the extreme modesty and indifference to praise displayed by the chief engineer, who was the brains of the whole operation, as well as the leader in the actual doing of the work. He acted as if it was all in the day's duties and called for no special commendation or notice, although there is hardly a doubt that if he had decided to do what many men would have done under the same circumstances—close the watertight door in the engine-room bulkhead—the ship would have been lost, because investigation showed that neither the tunnel casing nor the engine-room bulkhead would have withstood the pressure had the tunnel been allowed to fill.

Marine engineers have not in the past received, nor do they get now, the credit that is due them for the many deeds of valor they perform, although in later years they are receiving more recognition than they did 25 years ago. However, like all courageous men, they are not brave because of the recognition it brings. They are brave simply because they are brave.

Commander of the Newport.—Capt. James R. Driggs, who was selected by the board of governors as commander of the New York State Nautical Schoolship *Newport,* assumed command on Feb. 1. Capt. Driggs is a graduate of the schoolship *St. Marys,* class of 1882, and has spent his life in continuous service as an officer in the merchant marine.

Marine Articles in the Engineering Press

German Shipbuilding, 1913.—The statistics of the Germanic Lloyd show an increase of number and tonnage of ships building in 1913 over those in 1912, with a total of 1,384 merchant ships of 1,368,187 gross tons, of which 250 ships aggregating 1,167,442 gross tons are each over 100 tons; in addition there were building 54 warships of 161,780 gross tons. The increase in merchant ships is almost exclusively in ships over 100 gross tons, while the warship tonnage has actually decreased 15,000 tons below that of 1912. Objection is raised against gross tonnage as an accurate measure of the size of ships, as so much can be done arbitrarily toward a reduction of tonnage by special hatchways in deckhouses or upper decks, perhaps not found on other ships of equal carrying capacity. Also, so far as regards completed ships, 1913 showed the largest output, with a total of 914 merchant ships of 467,873 gross tons and 22 warships with 55,860 gross tons. The large tonnage of motor ships completed is characteristic for German shipbuilding, and also for Danish and Dutch shipbuilding, but it is almost wholly lacking in English shipbuilding. Considering the figures of gross tonnage still building at the end of the year 1913, the amount is greater than last year, with a total of 470 merchant ships of 900,314 gross tons and 32 warships of 105,920 gross tons. The additional tonnage is due to steam seagoing vessels, while seagoing motor ships and river boats show a reduction in tonnage. 3 tables. 1,000 words.—*Schiffbau,* January.

The Outfit of Wireless Telegraphy on the Imperator.—The article describes the unusually large outfit, which consists of two distinct plants, one long distance of 7.5-kilowatt antennæ energy, one of 1.5 kilowatts, and one for emergency. The antennæ of the large plant are four in number, 557 feet 9 inches long, while the small ones each have one wire from the mast to one of the stacks and to the station. Rotary transformers supply current for the two regular plants, while a storage battery can supply the emergency outfit for six hours. Wide variation of frequency of alternating current and of wave lengths is possible to adjust the telefunken system to give its musical sound with the required strength and clearness. The apparatus for the large and small plants is described in detail. The range proved far in excess of the guarantee of 990 miles for day and 1,980 miles for night service, as the ship usually is in connection with either Europe or America. The three operators are berthed in the station. 11 illustrations. 2,000 words.—*Schiffbau,* November 26.

U. S. S. Cummings, Trial Performance.—By Henderson B. Gregory. The trials of the *Cummings* were conducted Aug. 26 to 28 on the Rockland measured mile course. Twenty-six runs were made at various speeds, the data from which are tabulated and curves plotted for R. P. M. on knots and R. P. M. on shaft horsepower. On her four-hour full power trial the vessel made a speed of 30.574 knots with the engines developing a collective shaft horsepower of 16,335. 1 illustration. 800 words.—*Journal of the American Society of Naval Engineers,* November.

The Heating of Frame and Plate Furnaces.—By John Hamilton Paterson, D. Sc. This article has been written with a view to showing how the selection of suitable fuel may be accomplished and the proper burning of it adequately attended to. The unit chosen for comparison of different fuels is the gross number of heat units obtainable for one penny after all the costs of handling the fuel have been added to the price per ton. This unit is referred to as the "Absolute Heating Value (A. H. V.)." From the data presented the following values of this unit are found for certain fuels: Washed slack coal, 187,500; screened steam coal, 161,000; producer gas, 160,000; oil fuel, 41,000; town gas, 31,000. If these fuels can be burned in an ideal furnace, in which all the heat is utilized in heating frames or plates, it is evident that the poorer coals would be easily the most economical, good coal and producer gas being about equally efficient and oil fuel and town gas entirely out of the question. As it is not economical, however, to use high ash coal for firing frame furnaces, the proper construction of furnaces is considered in order to show which type of furnace is best suited for the various fuels and which has proved most economical. It is pointed out that with the most suitable furnace and with proper care in the selection of the coal used, the greatest economy possible can be effected by using producer gas, although many failures have been credited to this method of firing frame furnaces. The author points out the features which should tend to make such an arrangement a success. 4 illustrations. 2,850 words.—*The Shipbuilder,* January.

U. S. Fleet Colliers Proteus and Nereus.—By Henderson B. Gregory. These vessels, designed for a speed of 14 knots when carrying not less than 12,500 tons of cargo and bunker coal corresponding to a displacement of about 19,000 tons, with the main engines developing about 6,700 indicated horsepower, were built by the Newport News Shipbuilding and Dry Dock Company, Newport News, Va. Their main dimensions are: Length over all, 521 feet 9 inches; length between perpendiculars, 500 feet; beam, extreme, 62 feet 2½ inches; beam, molded, 62 feet; mean designed draft, 27 feet 6 inches; displacement at designed draft, 19,080 tons. A detailed description is given of the hull, the deck machinery, cargo gear, heating, ventilating, drainage, pumping and sanitary systems, and also of the main and auxiliary machinery. Propulsion is by two 3-cylinder triple-expansion engines, with cylinders 26, 43½ and 74 inches diameter, with a common stroke of 48 inches driving three-bladed propellers, 16 feet 6 inches diameter, 16 feet 5 inches pitch, as set, with a projected area of 79.11 square feet, a helicoidal area of 90.6 square feet and a disk area of 213.81 square feet. Steam is furnished at 200 pounds pressure by three Scotch boilers, 15 feet 9 inches mean diameter and 21 feet 5½ inches length of shell. Standardization trials were run over the Delaware Breakwater course, from which it was found that it required an average of 96.2 and 94.55 revolutions per minute of both main engines for the *Proteus* and *Nereus,* respectively, to give the contract speed of 14 knots. On the eighteen-hour full power trials the *Proteus* attained a mean speed of 14.675 knots with her engines developing 7,207 indicated horsepower. On this trial the *Nereus* attained a speed of 14.575 knots when developing 6,904 indicated horsepower. In addition to the standardization and power trials, tests were made of the coaling gear, and appliances. On the *Proteus* coal was delivered at the rate of 134.5 tons per hatch per hour, which is nearly twice the guarantee of 75 tons. On the *Nereus* the average rate of discharge per hatch per hour was even better, being 144.4 tons. 3 illustrations. 8,200 words.—*Journal of the American Society of Naval Engineers,* November.

German Paddle-Wheel Tugboat for the Rhine.—The firm of Sachsenberg Bros., in Rosslau, on the Elbe, completed in 1913 a paddle-wheel tugboat for the Rhine, the *Doertelmann Bros. II,* 240 feet long, 27 feet 11 inches beam, 10 feet 10 inches deep at side and 3 feet 11 inches draft. The boat has ten cross bulkheads, of which eight are watertight. The main deck is of corrugated iron. The crew is berthed forward and the officers aft, with the galley, toilets and storerooms on the

wheel sponsons. The bridge is between the stacks well up above the main deck. The auxiliary machinery equipment is very complete, containing steam and hand-steering gear, windlass, six towing winches on the forward deck, each with sufficient capacity to take an entire towing hawser. The hawsers are guided along and well above the deck and clamped to a built-up and braced wrought steel skeleton towing bit, six side towing bitts are arranged aft of the wheel casings and the short sponsons to hook up to barges aft alongside. The anchors hang under the bowsprit outboard; two boats are swung on davits on the forward deck. The mast and the two smokestacks can be folded down. The boat has two Scotch boilers, 13 feet 1½ inches diameter by 11 feet long, for 205 pounds working pressure, and a triple-expansion diagonal paddle-wheel engine with three cranks, normally developing 1,300 indicated horsepower. The paddle-wheels have each seven feathering curved steel buckets 15 feet 6 inches wide. 4 illustrations. 650 words.—*Schiffbau,* November 26.

New German Motor Boats of the District Teltow.—The large passenger traffic on lakes and rivers and canals of the district of the rivers Havel and Spree, near Berlin, requires special boats with continuous upper deck of large area and considerable shelter space below. The district authorities instituted in 1910 a prize competition for the best design suitable for the conditions, to have large passenger capacity, good speed and little wave disturbance, that might prove least destructive to canal banks. Twenty-three designs were offered. To test their efficiency, towing experiments were made in the experimental tank of the government in an exact copy of the profile of the Teltow Canal. The waves automatically recorded their heights by floats actuating recording pencils. The results showed that the principal factor of the wave-making in restricted canal profiles was the 'midship section, leading thus to a scow shape of boat with very full water-lines and the minimum of 'midship section. On strength of these investigations a new design was developed, and boats built by Saschenberg Bros. Company, in Rosslau, and named *Tempelhof* and *New Koelln.* Practically two full decks are provided with a small cabin near the engine room for seating accommodations for the passengers. The machinery plant consists of two oil engines of 50 horsepower each, built by H. Kamper, in Mariendorf, driving twin screws and reversing by clutches, which are operated by the pilot. The speed in open water is 10 to 10½ miles per hour. A comparison between the tests of a normal shipshape body and the new boats shows a remarkable reduction of wave heights to nearly one-half. The new boats are 98 feet 5 inches long over all, 17 feet 9 inches beam and 15 inches light draft. 31 illustrations. 1,850 words.—*Zeitschrift Verein Deutscher Ingenieure,* November 8.

German Railway Ferryboats for Hamburg.—The port of Hamburg had built recently two railway ferries for service across the southern channel of the Elbe, of the twin-screw double-ended type and similar to Glasgow ferries, with a movable deck to allow for changes in tide. The ships were built by the Vulcan Works, in Stettin, while the bridge-like construction of the movable deck and its support was sublet to the machine works, Augsburg-Nurnberg. The ships are 116 feet 6 inches long on the waterline, by 50 feet 10 inches molded beam by 12 feet 6 inches deep, with a light draft of 8 feet 2 inches and a load draft of 9 feet 3 inches with six 30-ton cars. Their weight, light, with 15 tons coal, is given as 930 tons and their speed as 8 knots. They are built of steel, strengthened for ice, and fitted with six transverse and two longitudinal bulkheads. A description is given of the girder structure, the movable deck and its lifting gear, deck fittings and mooring arrangements. The pilot house of teak contains control gear directly to the reversing lever of main engines, which steer the ship, the rudders being only supplementary. The triple-expansion engines are heavy, symmetrically arranged for ahead and backing motion and with a late cut-off for quick starting. The diameters are 12¼ inches and 18⅝ inches and 29⅛ inches by 19⅝ inches common stroke, and each engine develops 320 indicated horsepower at 150 revolutions per minute. The auxiliaries comprise 2 Brown reversing engines, 1 independent Edwards air pump, 1 circulating pump, 1 condenser of 861 square feet cooling surface, 1 dynamo, 1 steering engine, 1 windlass engine, 2 duplex feed pumps, 2 duplex bilge pumps, 1 deck lifting engine and 2 injectors. The shafting of each engine has 2 thrust blocks and 2 propellers. The feed water passes through an oil filter and a heater. There are 2 two-furnace Scotch boilers, each with 864 square feet heating surface and 28.4 square feet grate area, built for a working pressure of 176 pounds per square inch. 16 illustrations. 3 plates. 7,020 words.—*Schiffbau,* October 8-22.

Two-Cycle Diesel Marine Oil Engines, Developed by Werf Gusto.—This article gives a detailed description of a 200 brake-horsepower, three-cylinder, two-cycle Diesel engine built by Werf Gusto, Schiedam, near Rotterdam, for a Dutch passenger vessel. The engine is of the stepped-piston type, an extension of the main cylinder carrying the stepped extension of the main piston. With this design the scavenging pump is very shallow, while the bearing pressure between it and the cylinder wall is comparatively low and not subject to any great heat. Scavenging of the cylinders is accomplished by means of single ports, thus requiring no valves in the cylinder head, as the entry of the scavenging air into the cylinder is controlled by the travel of the main piston. The only valves in the cylinder head are the fuel injection valve and the starting air valve, driven in the usual way by cams and levers. Compressed air for fuel injection and for starting is supplied by a two-stage compressor driven off the end of the crank shaft. For powers above 300 brake-horsepower, Messrs. Werf Gusto adopt a cross-head type of two-cycle engine, which is remarkable in that the scavenging pump is combined with the engine cross-head, guide shoes and guides, the main cylinder being separated from the scavenging pump by a distance piece, which is also made to act as a reservoir for the scavenging air. 10 illustrations. 1,800 words.—*Engineering,* December 19.

The Channel Steamer Paris and Geared Turbines.—The Channel steamer *Paris* was built for the London-Brighton & South Coast Railway Company by Messrs. Denny of Dumbarton. The vessel is engined with Parsons turbines, driving the propellers through spur gearing. The power transmitted through the two gear wheels is about 14,000 shaft-horsepower, which is the most powerful installation of this type of machinery up to date. An indication of the progress made in the development of this type of machinery is gained from the fact that, while in 1910 the total power of geared turbines completed or under construction was 15,000 horsepower, in 1911 it was 32,500 horsepower, in 1912 it advanced to 118,050 horsepower, while to-day it is 435,450 horsepower. The *Paris* is 300 feet 6 inches long on the load-waterline, 35 feet 6 inches molded breadth, 23 feet 3 inches molded depth, with a gross tonnage of 1,774 tons. The mean draft on service is 9 feet ½ inch and the displacement 1,510 tons. The propelling machinery is arranged on two shafts, each driving a three-bladed solid propeller of Stone's "Turbiston" metal. On the trials between New Haven and Dieppe the propellers ran at 435 revolutions, giving a speed of 25.07 knots. The high-pressure and low-pressure turbines made 2,610 and 1,849 revolutions, the pinions being then in the relation of 6 and 4.25 to 1 of the gear wheel on the shaft. Each shaft has a high-pressure turbine and a low-pressure turbine, and an astern turbine is incorporated in each of the latter. 23 illustrations. 5,000 words.—*Engineering,* December 5.

New Books for the Marine Engineer's Library

Marine Turbines. By G. Bauer and O. Lasche. Size, 5½ by 8 inches. Pages, 442. Illustrations, 260. Munich, 1913: R. Oldenbourg. Price, $3.75.

The well-known German authority on marine engineering, Dr. G. Bauer, in conjunction with O. Lasche, has produced this volume as a supplement to his previous publications on marine reciprocating machinery. On account of their extensive experience with turbine work at the Vulcan Works, Stettin, and at the A. E. G. Works, Berlin, the authors were able to give a very large amount of valuable information covering the subject of marine turbines. Not only is there a complete theoretical treatment of the subject expressed in clear language with a minimum of higher mathematics, but also a complete discussion of the practical side of the subject, replete with descriptions of details, which will be much appreciated by men engaged in the actual construction of turbines.

The authors devote a few short chapters of introduction to the advantages, application, systems, power measurements, steam consumption and maneuvering qualities of the marine turbine. Following this are several chapters on general design, discussing the value of different diagrams, plotted either for pressure and volume or for temperature and entropy or for heat and entropy, and showing the calculation of the total efficiency of a marine turbine plant. It is also shown how this efficiency and the steam consumption are influenced by the vacuum, superheat or moisture of the steam.

From theoretical steam velocities, the reader's attention is directed to the influence of the forms of admission nozzles of various types upon the so-called critical pressure, and this is well exemplified by complete calculations. The distinction between reaction and impulse turbines is pointed out, as well as the working operation through the blades and their efficiency at different angles.

Blading is discussed in regard to strength, dimensions, division, etc., and also in regard to the effect of shifting the rotor in the axial direction, which requires the provision of relief pistons and dummies, usually so arranged and proportioned that they offset the propeller thrust and enable the thrust block to be quite small. The critical number of revolutions of the turbine shaft is exemplified, showing the great necessity for careful design, construction and balancing to prevent excessive deflections of the shaft under even a small eccentricity of the center of gravity.

General remarks on turbine plants deal with the number of shafts, the number of turbines on one shaft in either one or more casings, and with steam consumption, as well as the initial and final steam pressures, which are usually decided upon before the design is begun. It is pointed out how the choice of the diameters of the wheels or drums depends upon a number of factors, as, for instance, clear head room above the turbine, circumferential velocity and revolutions. Complete calculations are given for the layout of a drum turbine, as well as a mixed system turbine, with details regarding the pressure at the nozzles, the drumhead pressure, the drop of temperature in and the work done by the Curtis stages, the losses in the stuffing-boxes and the number of stages on the drum. Many readers will appreciate the approximate calculations for turbine plant and a statement of the proper or desirable dimensions of turbines.

The practical part of the book is devoted to the structural details of the forms and material of blades, their supports and clearances; also of the rotors and their shafts; of the guide blades; nozzles and subdividing disks; of the casings, mentioning the necessity for their careful design and construction; of the stuffing-boxes and the dummy rings; of the main and thrust bearings; of the steam piping and its details, such as the separator, stop valve, reversing valves, drain, oil and cooling water piping, and of the necessary lifting gear. Due attention is given to the shafting, its material and its bearings; to the propeller, its pitch ratio, its circumferential speed and area pressure, its limit of revolutions and its construction.

The various arrangements of turbines in a ship are described and examples given for a number of installations on torpedo boats, cruisers and battleships as well as merchant ships. Following a chapter on the exhaust steam turbine, the authors describe the Föttinger hydraulic transformer and the gear drive. A chapter is also devoted to each of the following subjects: Marine auxiliaries with steam turbine drive; measuring apparatus; practical instructions upon the operation and the conservation of marine turbines, and miscellaneous tables.

The large number of diagrams, drawings and plates, together with the use of clear print, good paper and excellent binding, add much to the usefulness and value of the book.

Resistance and Propulsion of Ships. By Dr. Eng. Rothe. Size, 7 by 10 inches. Pages, 287. Illustrations, 150. Berlin W., 1912: Mr. Krayn. Price, $2.85, bound.

The author states that in addition to the American and English investigations of the Frondes, Taylor, etc., he has considered for his deductions the experiments made by Germans. These latter and later investigations of Ahlborn, Flamm, Wagner, Gebern and Kempf have led the author to conclusions somewhat at variance with previous opinions. In the different forms of resistance he distinguishes force line, eddy, skin friction and cavitation resistances for totally submerged bodies. The stream line theory does not appeal to the author. For partly submerged bodies additional resistance is stated to be supplied by wave, wave surface and air disturbances. The author discusses the determination of resistance for new designs from the point of view of formulas, model experiments and deductions from similar ships. The accuracy of the first two methods appears to the author doubtful, as even the tank towing experiments may sometimes be misleading. The propulsion of ships deals successively with turbine propellers and counter propellers, paddle-wheels and screw propellers. For the latter two types several chapters are devoted to their construction, operation, strength and power effects and efficiency. The calculation of screw propellers is considered from previously-built propellers, for which three examples are given. In addition a number of tables of coefficients and data are given. The book represents a valuable attempt to make use of all the latest investigations and to harmonize them with all that is valuable and fundamental from former experience in this subject.

Zinc and Cadmium. By R. G. Max Lisbig. Size, 7 by 9½ inches. Pages, 598. Illustrations, 206. Leipzig, 1913: Otto Spamer. Price, $8.00.

The very size of the work indicates the thorough familiarity of the author with his subject. He takes up successively: the ores and other raw materials of the metals; their physical and chemical qualities and combinations and the laboratory processes of analysis; also an extensive history of the metals and the methods of obtaining them. A long chapter is devoted to modern methods, roasting furnace construction, retort making, mixing machinery and the methods and apparatus for reduction and condensation for making use of by-products and the refining of the metals. After giving a special short chapter to cadmium, the author touches upon the production and application of zinc, zinc white, zinc dust and cadmium, and concludes his work with two chapters on special methods of obtaining zinc. A number of statistical tables on production, price and existing plants are added.

ENGINEERING SPECIALTIES

Schmidt Marine Superheaters

The Schmidt fire tube superheater, manufactured by the Locomotive Superheater Company, New York, consists of collector castings and a system of units or elements made up of U-bent tubes, the material of which is cold-drawn seamless steel. The collector castings are located in either a vertical or horizontal position in the uptake end of the boiler. The units, which are arranged in groups leading in and out of the uptake end of the flues, are expanded in the flanges or collars, which in turn are fastened to the collector castings. In joining the ends of the unit pipes to the collector castings one end of the pipe is in communication with the header from the boiler and the other with the steam pipe leading to the engines. Thus the steam in passing from the boiler to the engines must pass through the units or elements in the tubes, where the superheating takes place. The connection between the units or elements and the collector castings is made by means of a single clamp using but one bolt or stud, thus facilitating the removal of the units should occasion demand their removal.

The units are formed by welding the straight sections of the pipe to a forged return bend, whose thickness is somewhat greater than the thickness of tube. By this form of construction each unit consists of a single continuous pipe and does away with screwed joints or connections which might be contributory to leaks. The construction of the Schmidt superheater is evident from Figs. 1 and 2, which show its application to an internally fired Scotch marine boiler.

The superheater may be installed in existing power plants at a comparatively low cost, resulting in fuel economy as well as increased power output. The reduction in the flue area for gases by the introduction of the superheater is not a serious matter if sufficient draft is provided and unit pipes of the proper diameter are used. As the coal consumption is greatly reduced by the increased efficiency of the plant, the volume of gases passing through the flues is proportionately reduced. It is claimed that this condition more than makes up for the restriction of gas area resulting from the installation of the superheater. If the draft should prove insufficient, it can be

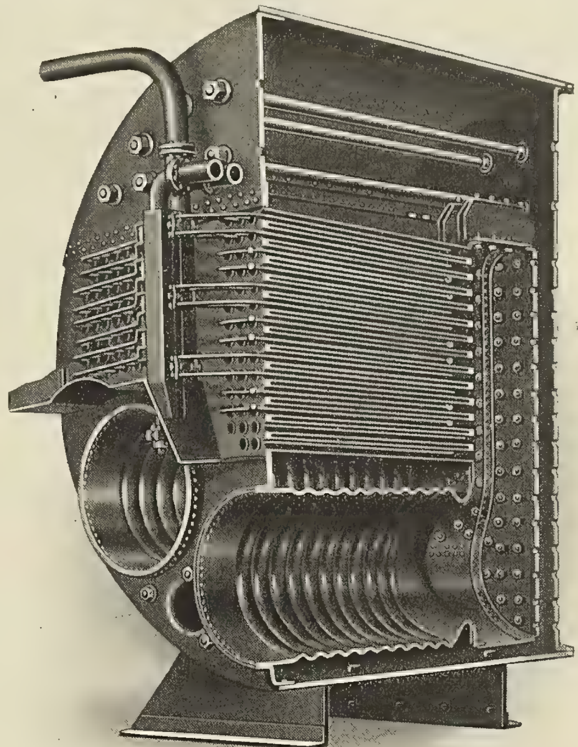


Fig. 2.—Sectional View, Showing Location of Superheater Elements in Fire Tubes

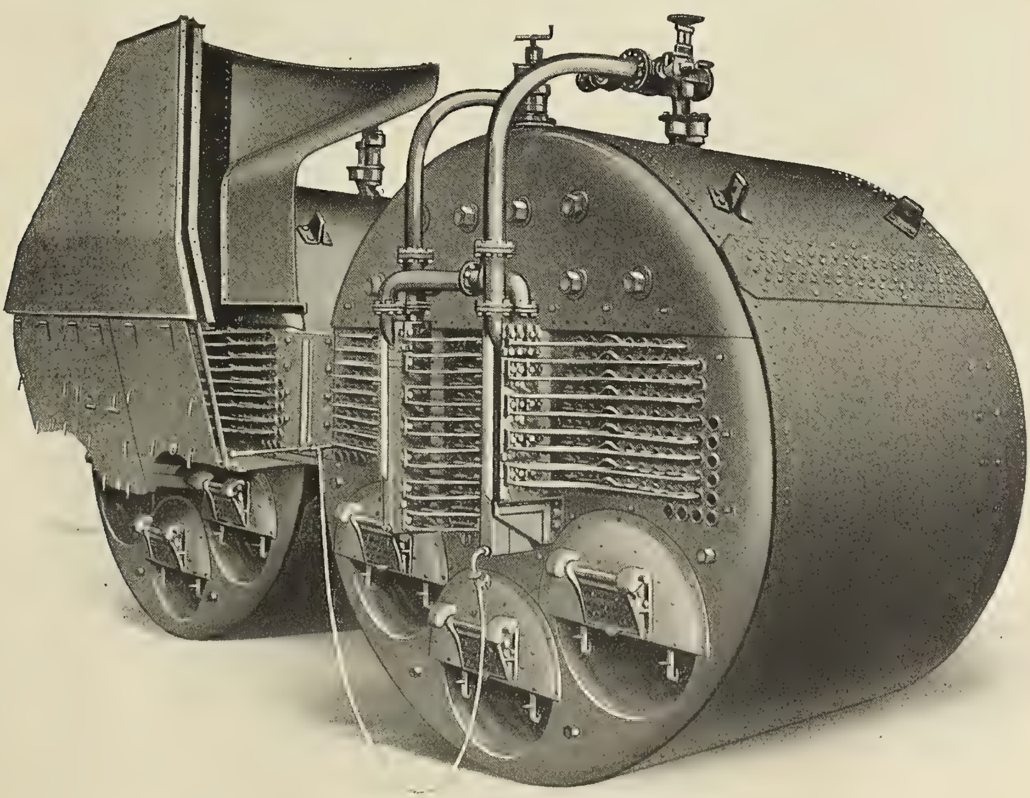


Fig. 1.—Schmidt Fire Tube Superheater Installed in an Internally Fired Marine Boiler

remedied by providing a forced or induced draft system of larger capacity. The cleaning of the superheater and boiler tubes can be easily effected by steam jets specially provided for the purpose and the introduction of the superheater pipes does not interfere with the well-known "Diamond" blower system used so extensively in cleaning flues while under way.

Where superheated steam is used, the material for pipe lines and fittings should be of steel and cast steel, respectively. Other metals, such as copper and bronze, lose their strength in high temperatures and should be avoided in piping and fittings that are to be used in connection with highly superheated steam. In selecting the engines to be used in connection with superheated steam, the high-pressure cylinders should, if possible, be served by either piston or poppet valves. The use of an inside admission piston valve for the high-pressure cylinder, as in ordinary practice, is the type of valve that will give satisfaction. For equal engine power the cutoff when using superheated steam must be somewhat increased above that for saturated steam. This variation can, as a rule, easily be obtained in the adjustment of the valve gear without any alteration in the position of the eccentrics. It is recommended that in new construction the high-pressure cylinder be made somewhat larger than is made for saturated steam, if it is desired to maintain the same cutoff in the low-pressure cylinder.

At the present time there are over 900 steam vessels, totaling over 1,000,000 horsepower, equipped with Schmidt marine superheaters.

The most economical results are obtained when a steam temperature of 580 to 620 degrees Fahrenheit is employed. The advantages claimed for this type of superheater are as follows:

1. It is adaptable to either new or existing boilers of the firetube type and can be applied with no change in design or construction.
2. It increases the output of power of a given marine power plant from 10 to 25 percent.
3. It will produce the same power output with fewer boilers.
4. It reduces the size of coal bunkers, thereby reducing the draft of the vessel with a given cargo or making possible an increase in revenue cargo.
5. It results in a saving of fuel over similar plants not equipped with superheaters as follows: Compound engines, 18 to 25 percent; triple expansion, 12 to 18 percent; quadruple expansion, 10 to 12 percent.
6. It reduces the maintenance cost by the prevention of water hammer, leaky flanges and condensation in the cylinders.
7. It permits rapid, thorough and frequent cleaning of the smoke and superheater tubes from ashes and soot without opening the smokebox door.
8. Its construction provides easy access to all screwed joints for ready removal of same.

Preventing the Spread of Flames in Pier Sheds

No matter what precautions are taken in the way of fireproof floors, enclosed escapes and doors that open outwardly, the lives of workers have frequently been jeopardized by the rapid spread of flames through inflammable material, even though the blaze has been confined to a single floor. This condition indicates that the real solution to the problem of safeguarding life and property is to provide adequate means for extinguishing the flames before they have a chance to gain headway.

To this end the H. W. Johns-Manville Company, New York, has brought out an extinguisher, known as the J-M Fyro, which discharges, by means of compressed air, a liquid gas said to be 40 times as effective as water. No mechanical force is required to operate it. All that is necessary is to hold it in an upright position and turn a small valve wheel about the size of a silver dollar. It measures only 3 by 15 inches and throws a spray as well as a stream; the spray can be thrown a distance of 10 feet; the stream 25 feet. The spray is most effective on small fires scattered over a comparatively large area; the stream is usually best for small fires concentrated in one spot. The advantage of the spray is that it will cover the entire blaze of the average incipient fire so that all of the liquid gas volatilizes. In so doing the gas forms a dense combustion-arresting "blanket," which is five times as heavy as air, and on account of its density and weight it quickly envelopes the flames, displacing oxygen and extinguishing the fire.

The Lennox Serpentine Shear

The Lennox Serpentine Shear, a new type of machine now being offered by Joseph T. Ryerson & Son, Chicago, is designed particularly for the straight and irregular cutting of sheets and plates. The frame is a steel casting of spiral construction designed to provide sufficient clearance for material of unlimited length or width. This machine will handle not only straight cutting, but also in or out curves having a minimum

radius only slightly larger than the diameter of the blades. The spiral steel frame carries all gearing and is mounted on a substantial cast iron base. All gears have teeth cut from solid metal and are provided with cast iron gear guards, so the workman is fully protected while operating the machine. The blades, which are made of high-grade tool steel, are set in approximately a horizontal plane. This gives a very large cutter bearing on the sheet or plate and, consequently, there is very little distortion in the cutting. The upper cutter is positively driven, while the lower cutter is mounted in an adjustable sleeve, so that its position may be varied to allow for different thicknesses of material and for redressing. In addition to this, a cam is provided so that the lower blade can be dropped enough to permit the removal of sheets without reversing the machine. The cutters have a flush fastening to the shaft, so that no nut projects to interfere with the handling of the work and the knurled edges feed the sheet automatically into the machine. A tool steel pin is provided to take up the end thrust on the lower cutter shaft. Where a number of sheets are to be cut to the same pattern, a template may be bolted to the work, and this template followed by guiding against the top cutter.

The machine is driven by means of a two-speed pulley, giving slow speed for intricate curve cutting and high speed for straight work. The main drive shaft is extended and squared on one end, so that a hand crank may be used if power is not available. This shear, it is claimed, will reduce cutting costs fully one-half by replacing old-style hand and power cutters, and thus saving time and labor in handling. The shear illustrated has a capacity for cutting No. 10 gage material and lighter, while other sizes having capacities of No. 16 gage ¼-inch and ⅜-inch material can be furnished. All machines are arranged for either belt and hand power or direct motor drive.

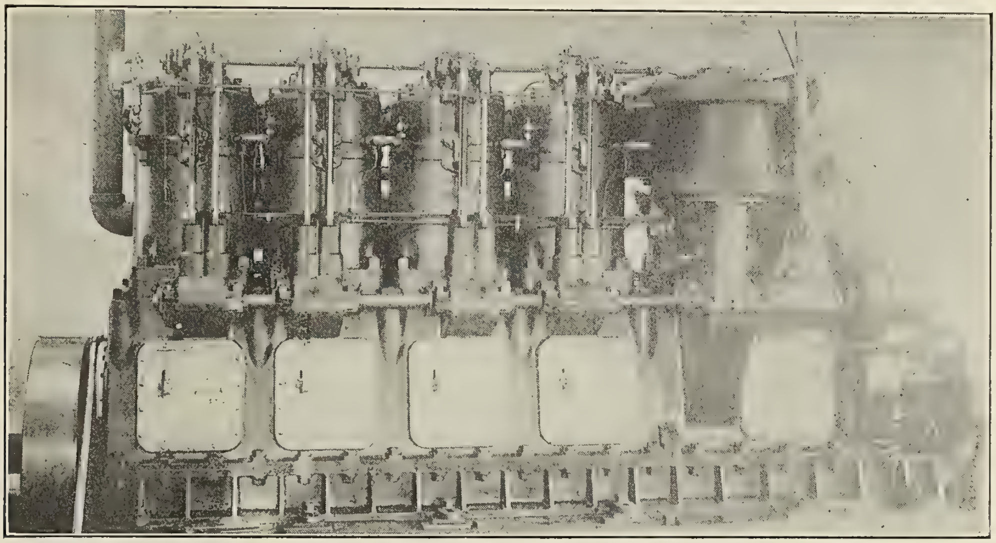
"Speedway" Fuel Oil Engine of the Diesel Type

The "Speedway" oil engine, just brought out by the Gas Engine and Power Company and Charles L. Seabury & Co., Consolidated, Morris Heights, N. Y., and exhibited for the first time at the New York Motor Boat Show in February, is of the two-cycle reversible type with valve scavenging. The size being built at present has four cylinders, 9-inch bore by 12-inch stroke. The scavenge air is furnished by a single cylinder operated by a crank on the after end of the crank shaft. The scavenge cylinder has a bore of 18½ inches by 10 inches stroke and works double acting, delivering air to a manifold running the length of the engine. The engine is of the closed type with cast iron frame and bedplate, both of which are strongly ribbed and secured together by means of long steel tie rods between the cylinders. The frame has large hand holes in both sides for easy access to the bearings. The crankshaft bearings in the bedplate are bronze babbitted, with removable shells. The cylinders are cast with integral water jackets of large capacity and central exhaust openings, also jacketed. The cylinder heads are separate and secured to the cylinders by means of light steel studs.

Each cylinder head contains two scavenge valves, one fuel valve, one air-starting valve and a relief valve. The cam shaft has its bearings in the frame and is driven from the crank shaft by means of spur gears. The fuel and scavenge valves are operated from the cam shaft by means of push rods and levers held in brackets on the cylinder cover. On the opposite side of the engine from the cam shaft is another shaft running the length of the engine, which carries cams for operating the air-starting valves. On this shaft are carried two sets of cams with tapered approaches. This shaft is operated by means of a hand lever, which, by pushing ahead, brings the ahead cams into action, giving the engine a start ahead. The other position of this lever in like manner brings the other set of cams into action, starting the engine astern. The fuel is pumped to the spray nozzles by means of a separate pump for each cylinder. The suction valves of the fuel pump are controlled by means of a lever so that they can be held open for a longer or shorter period, thus controlling the amount of oil pumped to the cylinders. The cam shaft is driven through a spiral sleeve, by which means the engine can be reversed by shifting a lever operating to rotate the cam shaft through an angle of 30 degrees. The scavenge cylinder has a piston valve, which eliminates the clatter of automatic valves. This piston valve is driven from the cam shaft and is also shifted by the reverse lever. The pistons are of the trunk type, extremely long, having dished heads. Each is fitted with eight spring rings.

All parts of the engine are designed to allow accessibility for the removal of parts. The spray nozzles are of steel and can be very readily removed for examination and replaced without disturbing adjustments. All valves in the cylinder head are easily removed independently. It is also a comparatively simple matter to remove a cylinder head.

Lubrication for the main bearings, crank pins and wrist pins is by means of a pressure system, the oil being forced through holes in the crank shaft by means of a pump driven from the after end of the crank shaft. Lubrication for cylinders and air compressors is supplied by means of a forced feed manifold oiler. The flywheel is carried on the forward end of the crank shaft, keyed to the tapered end. On the after end of the crank shaft is fitted, in an oiltight compartment, a roller thrust bearing of large size. The thrust compartment is so arranged that the entire thrust can be readily removed for examination without disturbing other parts of the engine. A two-stage compressor is driven by means of links and levers from the scavenge pump crosshead. This pump keeps the spray air bottle charged to 1,000 pounds, excess air escaping into air-starting bottles which are kept charged to 750 pounds pressure. A butterfly valve is fitted in the suction of the first stage compressor, so as to regulate the amount of high-pressure air. A double air cooler is attached to the engine frame just forward of the high-pressure compressor to cool the outer air from the two stages; the circulating water passes through this cooler first, so that the maximum amount of cooling is obtained.



The engine is operated entirely from the after end, where all controls are located, together with the gage board and forced feed lubricator. The control levers are four in number, consisting of the main reverse lever, the air-starting lever, the throttle lever controlling the oil and the spray air lever controlling the air pressure by means of a reducing valve. By

having separate control levers a very simple gear is obtained, which is easy to handle and can be kept in working order.

The operation of starting consists in placing the main reverse lever either ahead or astern, then placing the throttle and spray air levers in starting positions, and finally by means of the air starting lever giving the engine a start in the direction corresponding to the setting of the reverse lever, all of these operations taking much less time in their actual performance than it takes for the telling.

The engine develops 175 horsepower at 350 revolutions, and may safely be run at 400 revolutions per minute. The weight complete is 16,500 pounds.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

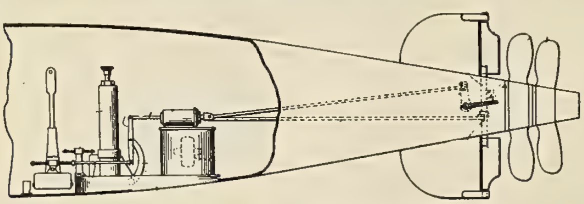
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,079,208. APPARATUS FOR CLEANING THE HULLS OF SHIPS OR ANY KIND OF VESSEL. FREDERICK GEORGE BROWNE OF MALVERN, NEAR MELBOURNE, VICTORIA, AUSTRALIA.

Claim 2.—An apparatus for cleaning the hulls of vessels, comprising in combination, a support floated beside the vessel to be cleaned, a member pivotally carried by said floated support and extending derrickwise between said support and the hull of the vessel to be cleaned, whereby its head may be adjusted at varying heights in contact with the hull to be cleaned, a cleaning device suspended by a plurality of points from the head of said pivotally carried member so that it is thrown into contact with the hull when said member is positioned to space the support from the hull, means to draw said support toward the hull to hold the head of said pivoted member in contact therewith and rigidly brace said support, and means for varying the relative angular positions of the points of suspension of the cleaning device whereby to utilize the weight thereof to adjustably create a pressure of the cleaning device against the hull. Three claims.

1,080,116. STEERING MECHANISM FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, NEW YORK, ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, NEW YORK, A CORPORATION OF WEST VIRGINIA.

Claim 1.—In a torpedo, the combination with the hull and lateral and depth steering means, of steering mechanisms for such respective means,



and a single support for both such mechanisms, removable at will from the hull. Fourteen claims.

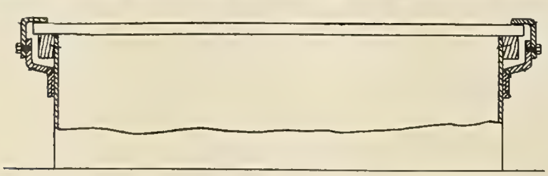
1,080,876. LIFE-BOAT. ANDREAS B. ANDREASSEN, OF BROOKLYN, NEW YORK.

Claim 1.—A boat having a hull provided with transverse bottom compartments for water ballast, a pipe passing through one of the compartments and opening through the sides of the hull below the water line, a pipe connected to said pipe, a valve for shutting off and establishing communication between said pipes, the second-mentioned pipe having branches extending respectively into the transverse compartments, a valve in each of said branches, and a pump having its inlet connected to the second-mentioned pipe. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

23,449/1912. IMPROVEMENTS IN HATCH COVERS AND COAMINGS FOR VESSELS. E. F. GLOVER, THOMAS LYON AND J. NEVILL, ALL OF 11 REDCROSS STREET, LIVERPOOL.

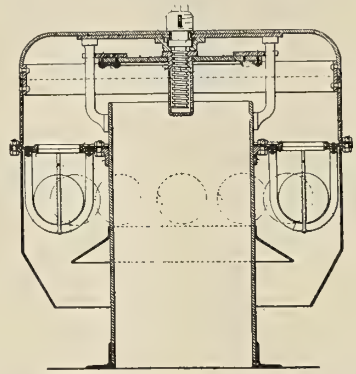
An improvement on Weir's Patent, No. 26,756 of 1909, consists in employing a worm and wheels or other power multiplying device that



will stand locked in any position for winding off and on the cover. A smooth bar or angle plate such as shown is fixed at the inside or outside of the hatch frame, with its upper surface a trifle above or level with the hatch on which the cover can run with little friction, and a molding is hinged and hooked over the cover, or formed in two or more pieces, as shown, to overlap the cover at the edges and prevent water from entering the hatchway. A ratchet and pawl is provided for automatically preventing the roller from being worked in the reverse direction.

8,618/1913. IMPROVEMENTS IN SHIPS' VENTILATORS. J. BROADFOOT & SONS, LTD., OF INCHHOLM WORKS, JAMES STREET, WHITEINCH, GLASGOW.

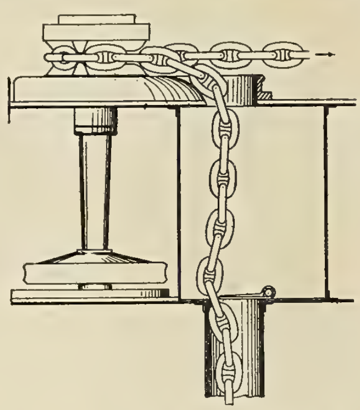
Claim.—A ship's ventilator having a stationary hood depending over the upstanding end of a ventilating trunk is provided with a horizontal



apertured diaphragm extending between and making a tight joint with hood and trunk. Valve seats surround the apertures in the diaphragm and a series of buoyant balls act as valves coacting with the valve seats, cages holding the balls beneath the seats. A disk valve is arranged to engage and make joint with the horizontal top of the ventilating trunk, the valve being operated by a screwed spindle projecting through the hood and being provided externally to it with means for its operation. The disk valve is prevented from rotating when acted on by the screwed spindle. One claim.

12,128/1913. IMPROVEMENTS IN THE DROPPING OF ANCHORS. C. D. B. HANSEN, OF 38 BERKELEY STREET, GLASGOW.

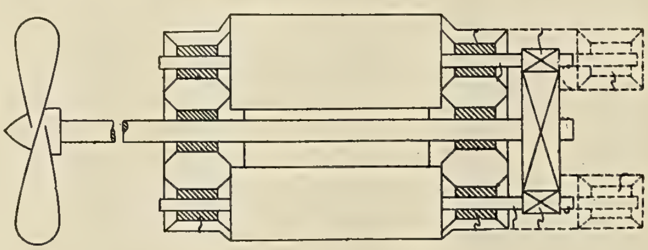
Claim.—An auxiliary locker is arranged immediately under the windlass deck and in communication with the main locker in the ship's bottom and provided with an opening or aperture in its floor, which



opening is closed with a cover or lid operated by quadrantal rack and pinion, or by block and tackle, and so fitted that when all the cable has run out of the auxiliary locker the lid is made to open automatically and allow the cable in the main locker to run out freely without construction. One claim.

14,832/1913. IMPROVEMENTS RELATING TO GEARED PROPELLER SHAFTS FOR SHIP PROPULSION. G. & J. WEIR, LTD., AND J. G. WEIR, OF HOLM FOUNDRY, CATHCART, GLASGOW.

Comprises an arrangement of mechanical gearing for the driving of the propeller shafts of ships in which the propeller shaft is extended



forward alongside the prime mover or movers, the gearing being located forward of the prime mover or movers, and the propeller shaft and driving shaft or shafts provided with bearings rigidly connected together and at the forward end of the prime mover or movers and adjacent to the gearing, and also with bearings rigidly connected together and at the aft end of the prime mover or movers.

International Marine Engineering

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New Great Lakes Steamship South American

Description of a Single-Screw Passenger Steamer Now Under Construction at the Great Lakes Engineering Works for 1914 Delivery

The Great Lakes Engineering Works, Detroit, Mich., now has under construction for the Chicago, Duluth & Georgian Bay Transit Company a steel screw steamship which will be named the *South American*. The steamer will have a capacity of 540 passengers and a crew of 161 and will be used exclusively in the passenger trade between Chicago, the Georgian Bay ports and Duluth.

General Arrangement

Forward on the lower or orlop deck is the main dining room with accommodations for 276 passengers, and the pantry. The dining room is finished in silvered oak with cork tile floor. Below the dining room and pantry are located large storerooms, refrigerators and fresh-water tanks. Aft on this deck are the bar and crew's quarters. The bar is located directly

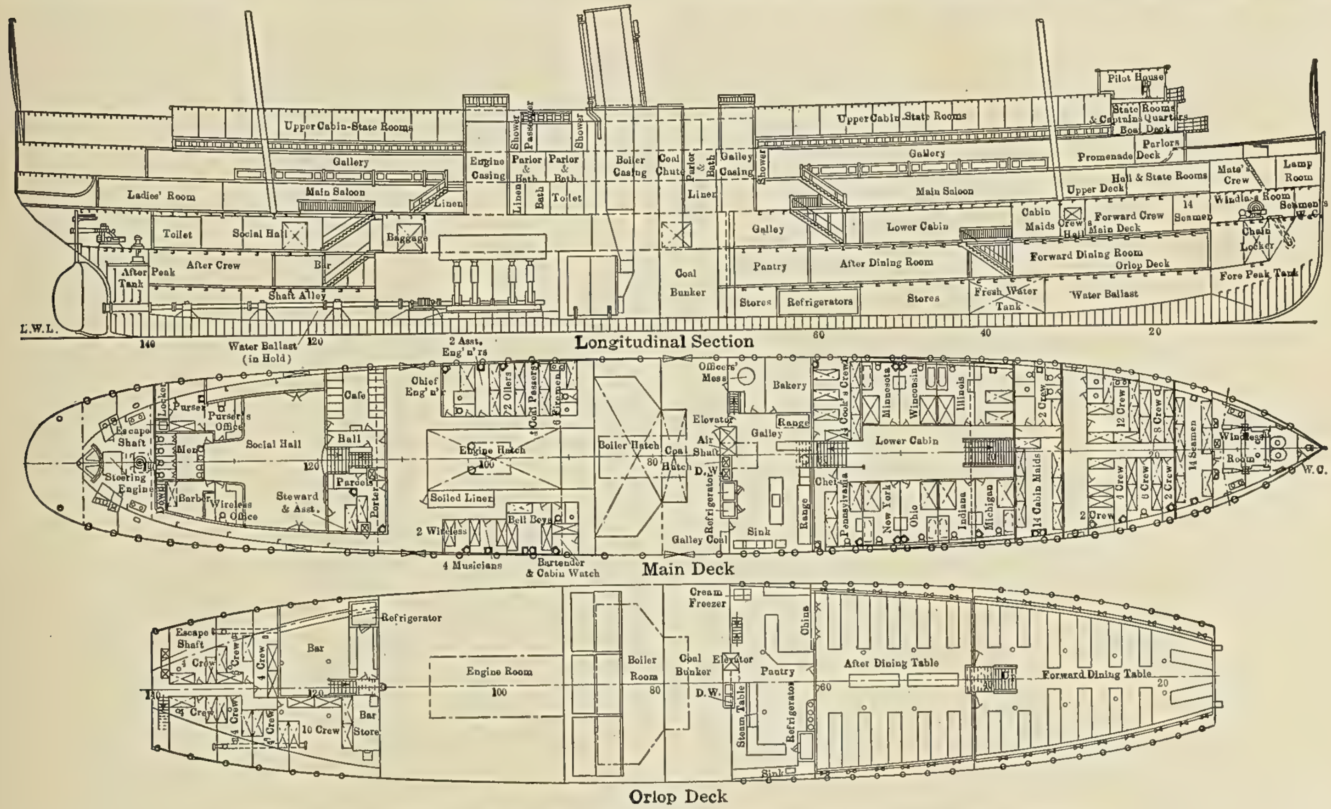


Fig. 1.—Inboard Profile of the *South American* and Plans of the Main and Orlop Decks

The principal dimensions are:

Length over all	314 feet.
Length on keel	291 feet.
Breadth, molded	47 feet.
Depth, molded	18 feet.
Service speed	17 miles per hour.
Maximum service speed	18 " " "

The vessel has five complete decks, the lower three being of steel. Six watertight bulkheads divide the ship into seven watertight compartments.

under the social hall and is finished in fumed oak with tiled floor. There is a built-in refrigerator and a large storeroom.

On the next deck above, which is the main deck, space in the stern is given over to the social hall and the passengers' entrance. These rooms are finished in birch and leading from the social hall are the purser's room, barber shop, café and parcel check room. Forward of the social hall are the baggage room and accommodation for the engineer's crew.

Amidships on the main deck, directly over the pantry, is the galley, which is connected by elevator and dumbwaiters to the pantry and storerooms below. Just forward of the galley is the lower saloon, opening out of which are nine par-

lor staterooms, each with private bath and fitted with double brass beds and mahogany furniture. Stairs lead from this saloon directly to the dining room below.

At the extreme forward end of the main deck is the windlass room with a No. 8 steam spur gear windless. The chain locker is below in the forepeak, while between the windlass room and the lower saloon are quarters for the dining room and cabin crew.

The main saloon is on the upper deck, and is reached from the social hall below by the main stairway. The main saloon to a gallery which overlooks the main saloon. Access to the gallery is provided by broad stairways forward and aft of the engine and stack casings. At the head of both stairways are hallways on either side opening on to the deck.

A covered promenade 9 feet wide and furnished with deck and steamer chairs extends entirely around the ship. At the extreme after end, inclosed by wire guards, is a children's open-air play-ground supplied with swings, hammocks and various out-door games. A large box of pure white sand is also provided for the amusement of the smaller children.

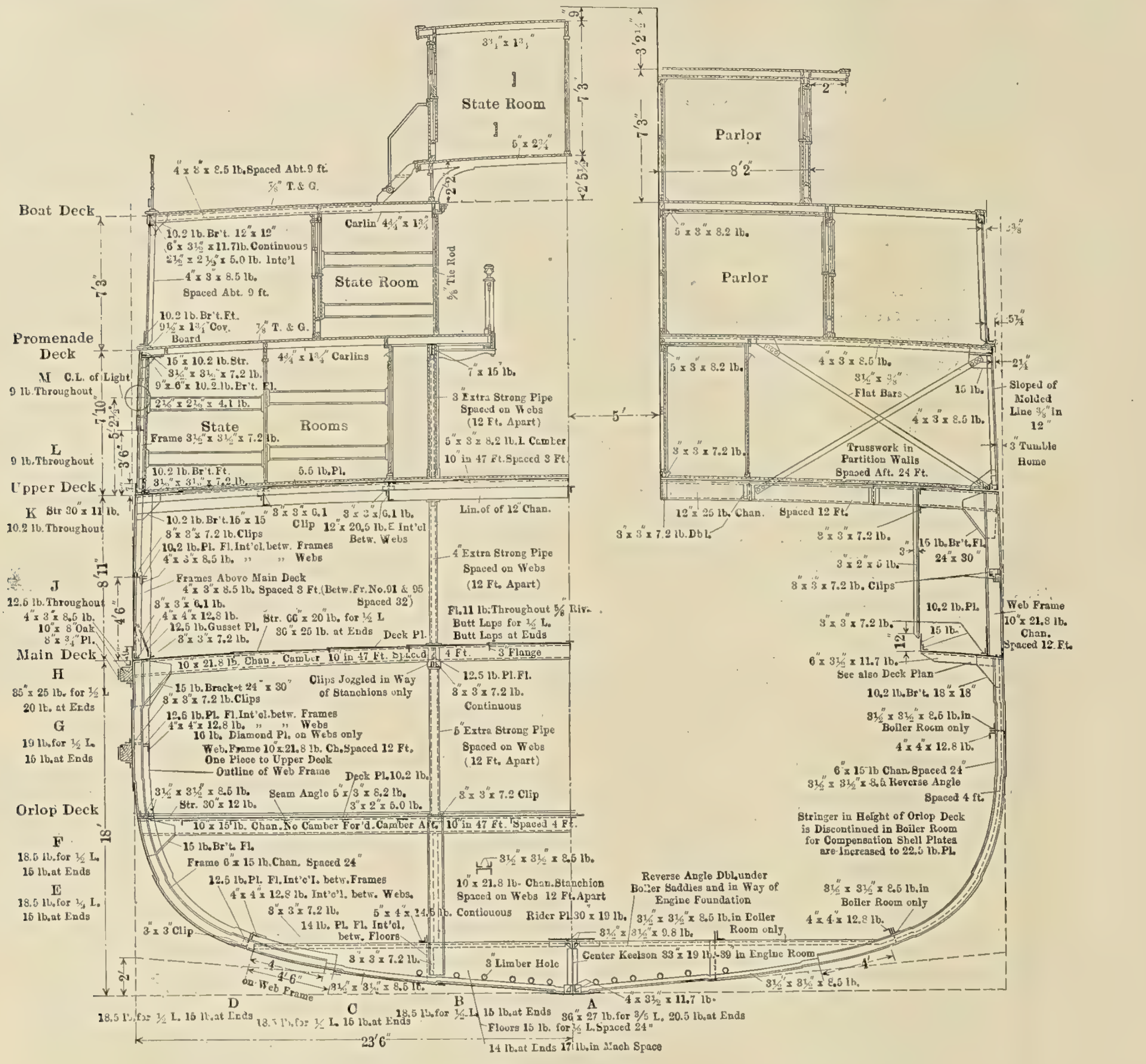


Fig. 2.—Midship Section

is finished in cream enamel, and leading off from it are 128 staterooms with accommodations for 256 passengers. Separated from the main saloon by a glass partition and French doors at the after end, is a ladies' cabin finished in silvered oak. Both the main saloon and the ladies' cabin are furnished throughout with comfortable leather chairs and settees. Quarters for the petty officers are also located on the upper deck, but they are forward of the main saloon and separated entirely from it.

The deck above the upper deck, which is known as the promenade deck, is given over entirely to staterooms and a covered promenade. In addition to 52 staterooms with 104 berths, on this deck, there are also 14 parlor staterooms with baths accommodating 28 passengers. The staterooms open on

On the boat deck are 57 staterooms and 8 parlors with bath, giving a total capacity of 134. At the forward end of the boat deck and directly under the pilot house are quarters for the captain, consisting of an office and stateroom. At the extreme after end of the boat deck is a glass inclosed ball room and observation room, provided with a maple dancing floor.

The ship has running water in all staterooms and both hot and cold water in all parlors.

Lighting is by electricity, the current being supplied by two 50-kilowatt turbine generators. In the main saloon, the lighting is on the indirect principle. Mechanical refrigeration is supplied to all cooling rooms by a 12-ton refrigerating plant. All water used for domestic purposes is filtered.

Every possible appliance to insure safety in operation is provided, including the Schutte recording compass and Nicholson log. Lifeboats and rafts of sufficient capacity to accommodate the entire complement of passengers and crew are provided, while a wireless equipment with a radius of 250 miles is installed.

Propelling Machinery

The main engine of the *South American* is a vertical quadruple expansion engine, having cylinders 21½ inches, 30¾ inches, 44½ inches, and 64 inches diameter, with a common stroke 36 inches. The estimated indicated horsepower at 115 revolutions is 2,550, while the maximum indicated horsepower will probably reach 2,850 with an increase in the number of revolutions to an estimated maximum of 125. The usual arrangement of the cylinders has been followed and the sequence from forward to aft is high pressure, low pressure, second intermediate and first intermediate pressure. The crank sequence is high pressure, first intermediate, low pressure, second intermediate.

A great deal of attention has been given to the proper balance of the moving parts of this engine, inasmuch as the length of her run will not permit of any perceptible vibration throughout the ship, which, while always objectionable in any ship, would seriously interfere with the earning capacity of this vessel in particular.

The high-pressure and first intermediate cylinders have one piston valve each, the diameter and travel being 12 inches and 5½ inches for the high-pressure and 17 inches and 6 inches for the first intermediate. The second intermediate cylinder has two piston valves, each 14 inches in diameter and 6 inches travel and the low-pressure cylinder has a double-ported slide valve with a travel of 6½ inches. All valves are driven with Stephenson link motion, the low-pressure having a balance cylinder.

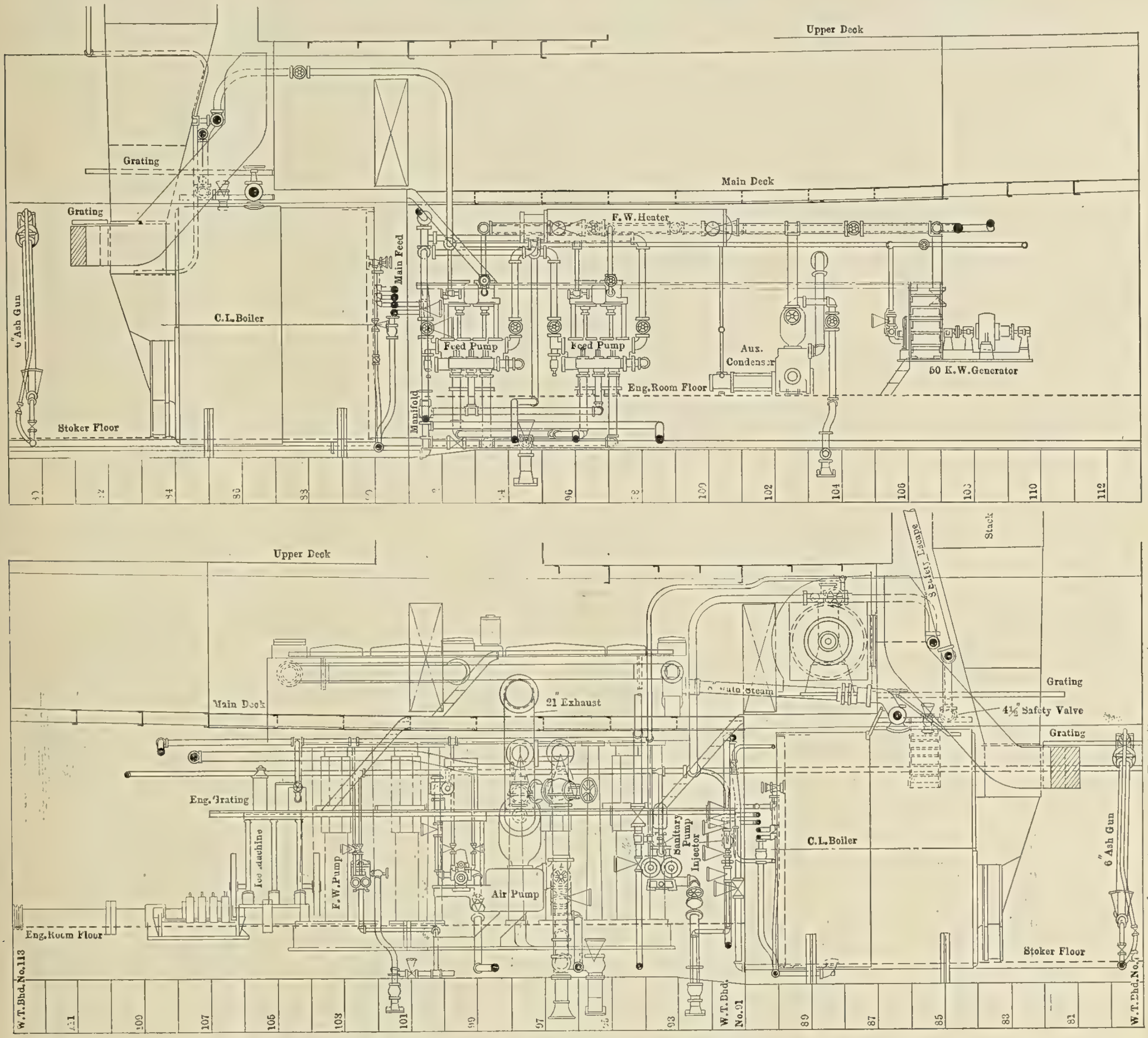


Fig. 3.—Port and Starboard Views of Machinery Space, Showing Piping Arrangement

The high-pressure piston is a plug piston of cast iron, fitted with anti-friction rings. The first intermediate piston is of cast steel fitted with a solid removable follower of iron and the second intermediate piston is similarly arranged, with the exception that the piston body is of iron and purposely weighted to assist in the balance. The low-pressure piston is of cast steel with packing rings and removable follower plate. All pistons are conical in section and the low-pressure and first intermediate are made as light as possible.

The piston rods of open hearth steel are 5⅛ inches in diameter in the body, secured to the pistons with a 3¾-inch nut and to the crossheads with a taper key. The crossheads are

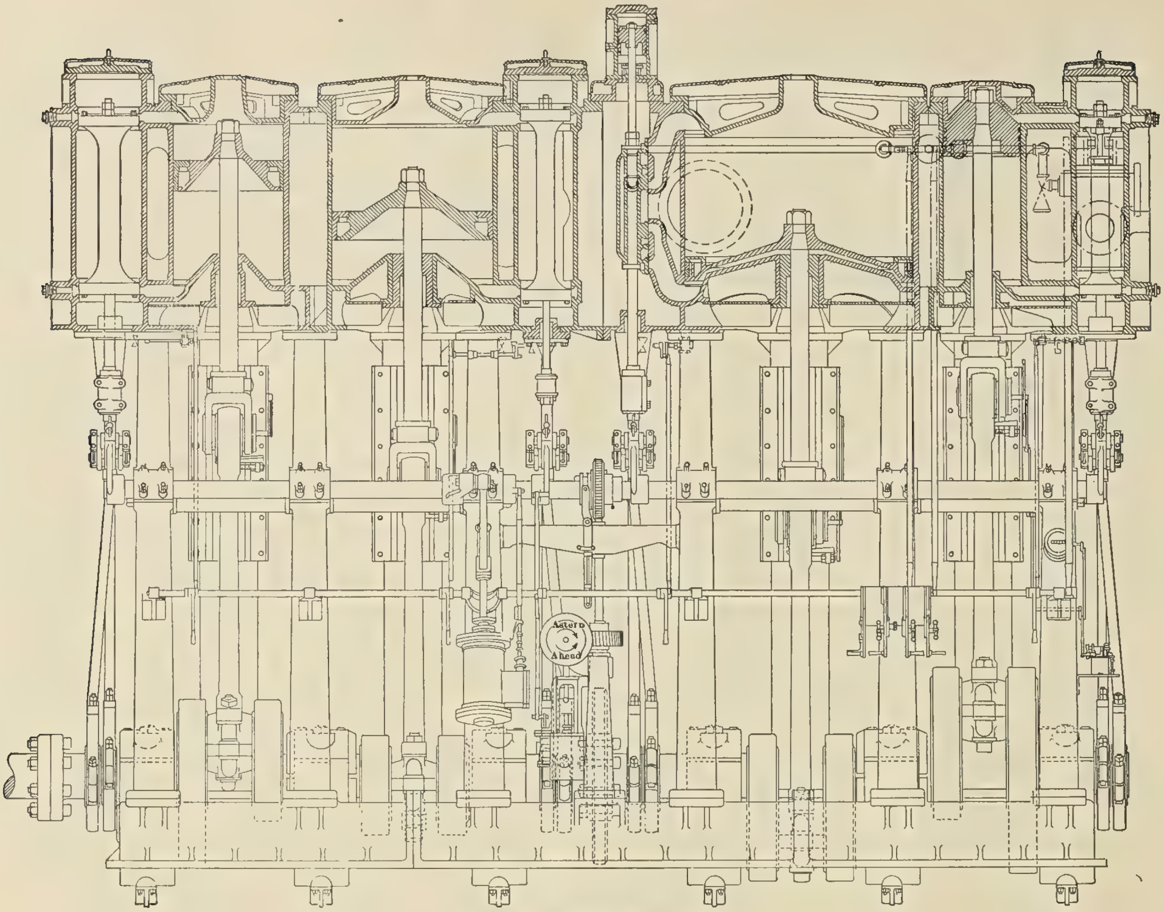


Fig. 4.—Main Engine

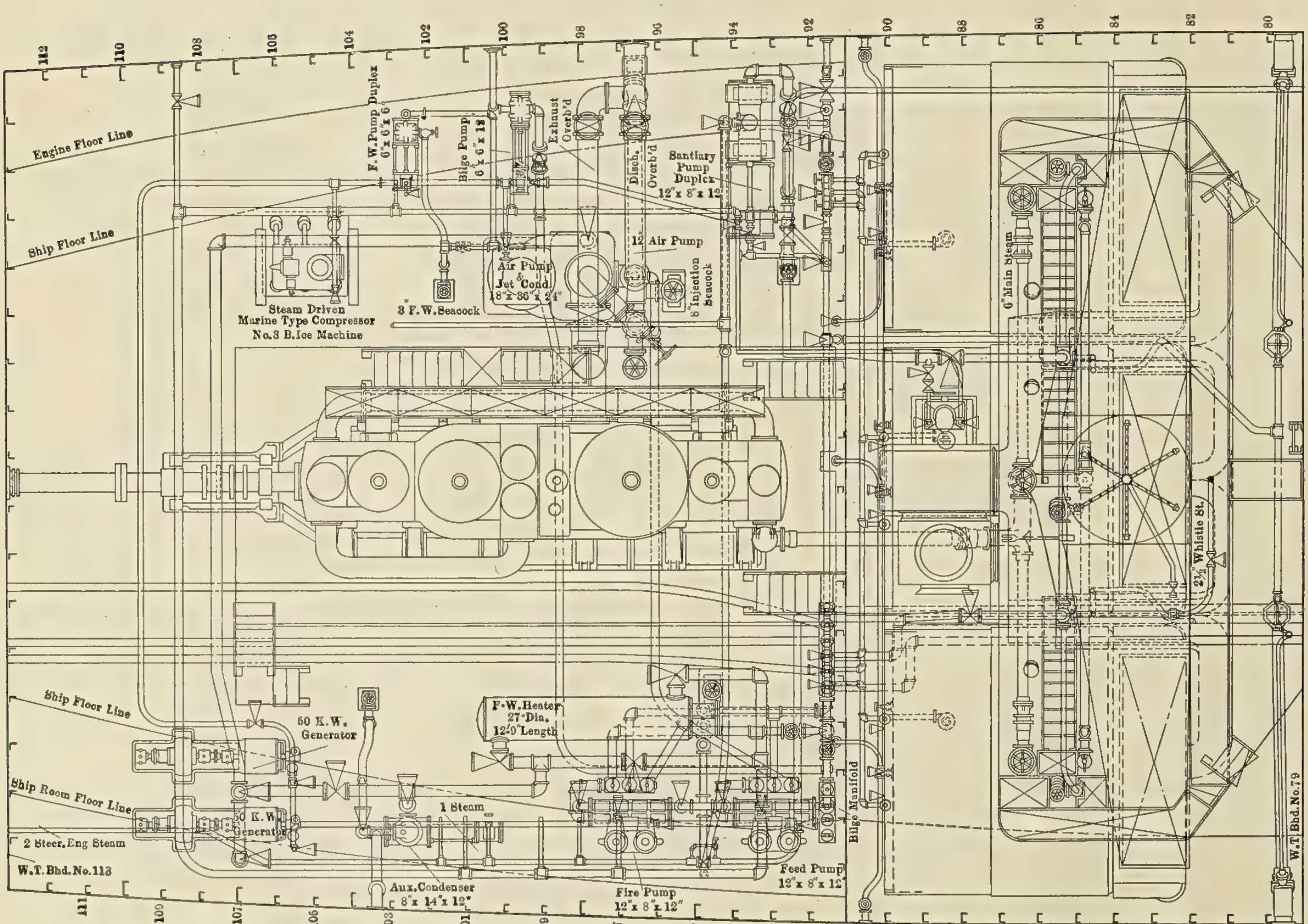


Fig. 5.—Plan of Machinery Space

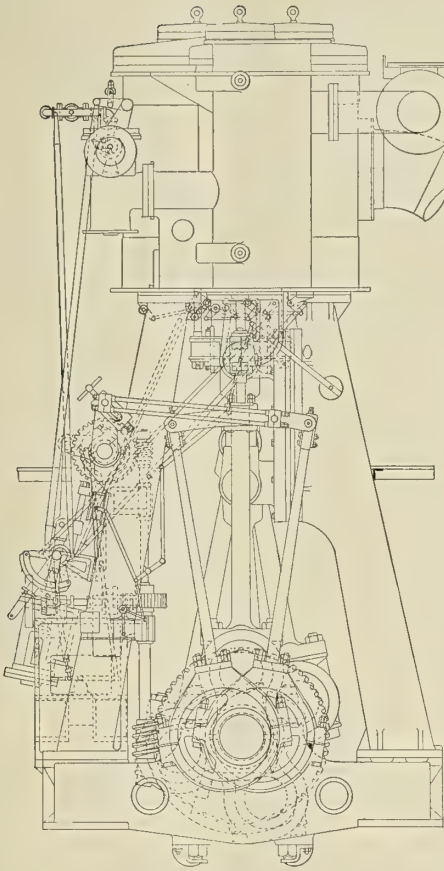


Fig 6.—End View of Main Engine

of cast steel fitted with removable brass shoes for both ahead and backing slides, while the crosshead pins are of machine steel taper fitted to the crossheads and are 6 inches in diameter by 8½ inches long.

The connecting rods are of open hearth steel 7 feet 3 inches long center to center, with brass top end boxes, adjustable for wear with a taper wedge. The crank pin boxes are of cast steel lined with babbitt and secured to the tee-ended connecting rod with annealed steel bolts, 2¾ inches diameter and a 3-inch thread. The connecting rod body is 4¾ inches in diameter at the top and 5¾ inches at the bottom.

The crank shaft is of open hearth steel of the built-up type with cast steel slabs securely shrunk and pinned to the shaft. The diameter of the crank shaft and crank pins is 12½ inches and the length of the crank pins 12½ innches. The shaft is supported in six journals, two of which are 19½ inches long and four 15 inches long, all lined with babbitt and having semi-steel caps secured with steel binder bolts, 3¼ inches in diameter.

The thrust bearing is of cast iron with cast iron shoes faced with babbitt and fitted for water circulation; the thrust pressure being taken up on four collars with a unit pressure per square inch of about 60 pounds.

The thrust shaft is of open hearth steel 12 inches diameter with coupling and thrust collars forged on. The line shaft is also of open hearth steel 12 inches diameter, supported in babbitt-lined, steady bearings placed at intervals not exceeding 18 feet. The tail shaft is 12½ inches in diameter in the body and 13½ inches in the stern bearing, which is 5 feet 7 inches long.

The propeller is of the sectional four-bladed type 12 feet 9 inches diameter, with a uniform pitch of 14 feet 9 inches and a developed total blade surface of 62 square feet. The hub and blades are of special mixture of tough cast iron with machine steel studs and brass nuts.

The bedplate and both front and guide columns of the engine are of cast iron box sections, all properly and securely bolted at their various points of connection. Reversing of the engine is accomplished with a direct-acting steam cylinder 10 inches bore and 15 inches stroke, and a double auxiliary reverse and turnover engine is provided, having cylinders 4½ inches bore and 6 inches stroke. This engine is so arranged that it automatically stops when the valve gear of

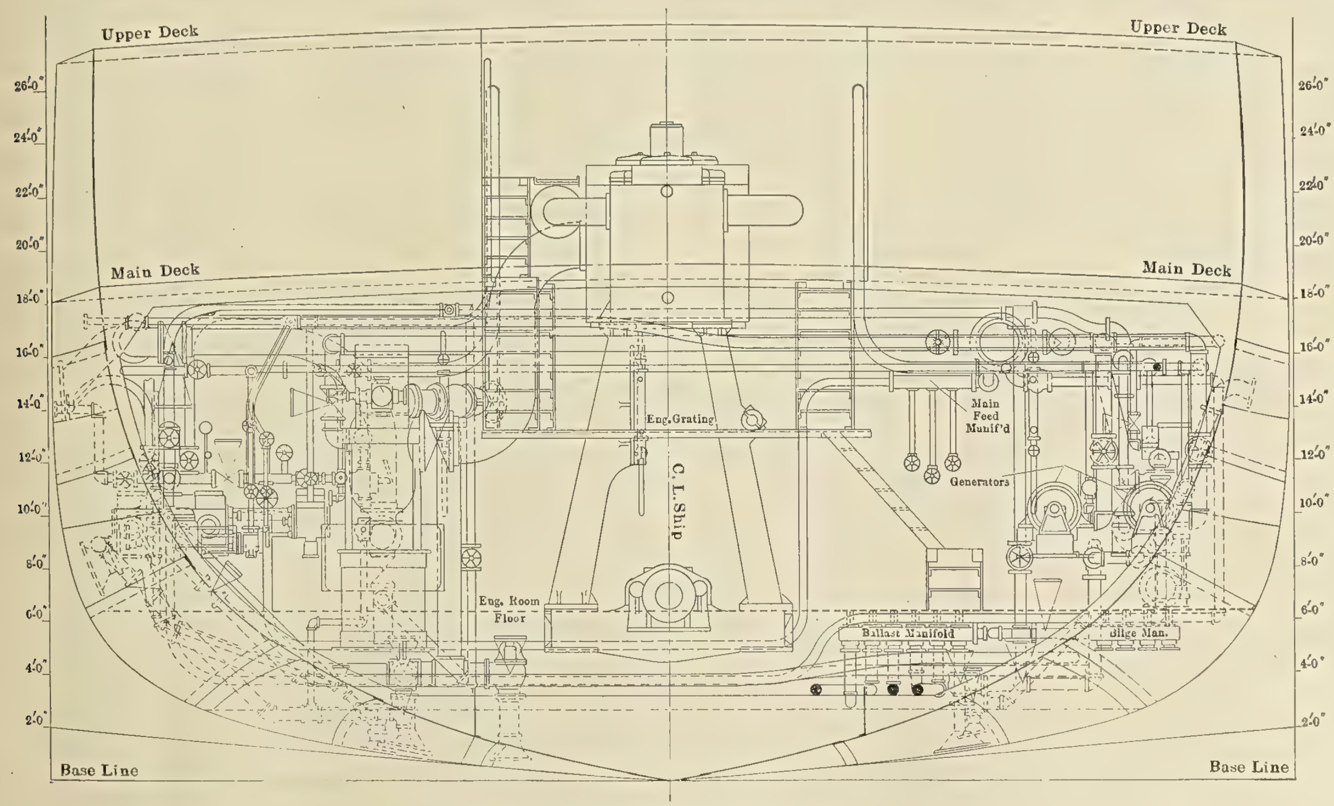


Fig. 7.—Section Through Engine Room

the main engine has reached either full ahead or astern positions.

Main Boilers

The main boilers are three in number, each 14 feet mean diameter and 12 feet long overall, built for a working pressure of 215 pounds per square inch. Each boiler has 3 corrugated furnaces, 42 inches inside diameter, and separate combustion chambers. The total heating surface of the three boilers is 7,293 square feet, and the total grate surface 157½ square feet, making a ratio of heating surface to grate area of 46.3 to 1. The boilers work under a system of positive heated draft, the air being led to the furnaces through a system of ducts and not upon the closed stokehold system.

The individual main steam stop valves on each boiler are 6 inches diameter and the steam pipe to the engine throttle 8 inches diameter. The auxiliary stop valves are 3 inches in diameter, safety valves 4½ inches, the feed valves 2 inches, the main blow-off 2½ inches, and the surface blow-off 1½ inches, in diameter, respectively.

Engine Room Auxiliary Machinery

All the pumps in this ship are independent of the main engine. The main air pump is a vertical double-acting pump of the simplex type, having a steam cylinder 18 inches in diameter and 24 inches stroke, and the air cylinder 36 inches diameter and 24 inches stroke. Feed pumps in duplicate are fitted, each pump being 12 inches by 8 inches by 12 inches of the duplex type. One sanitary and fire pump, duplex 12 inches by 8 inches by 12 inches, one bilge pump, simplex, 6 inches by 8 inches by 12 inches, one fresh-water pump, duplex, 5 inches by 6 inches by 6 inches, one auxiliary condenser and simplex air pump 10 inches by 14 inches by 12 inches, complete the list of pumps fitted; each being properly piped to perform its individual duty, the main air pump being connected to the engine room bilges, also, for use in emergency.

The engine for driving the forced fan is a vertical single engine, 6 inches bore and 6 inches stroke.

Current for all electrical requirements is furnished by two 50-kilowatt turbine-driven generators.

The refrigerating machine is of the vertical type, with one steam cylinder and one compressor of 12 tons per 24 hours, refrigerating capacity.

A feed water heater and internal type feed water purifiers are fitted, all in accordance with the latest practice for this class of apparatus.

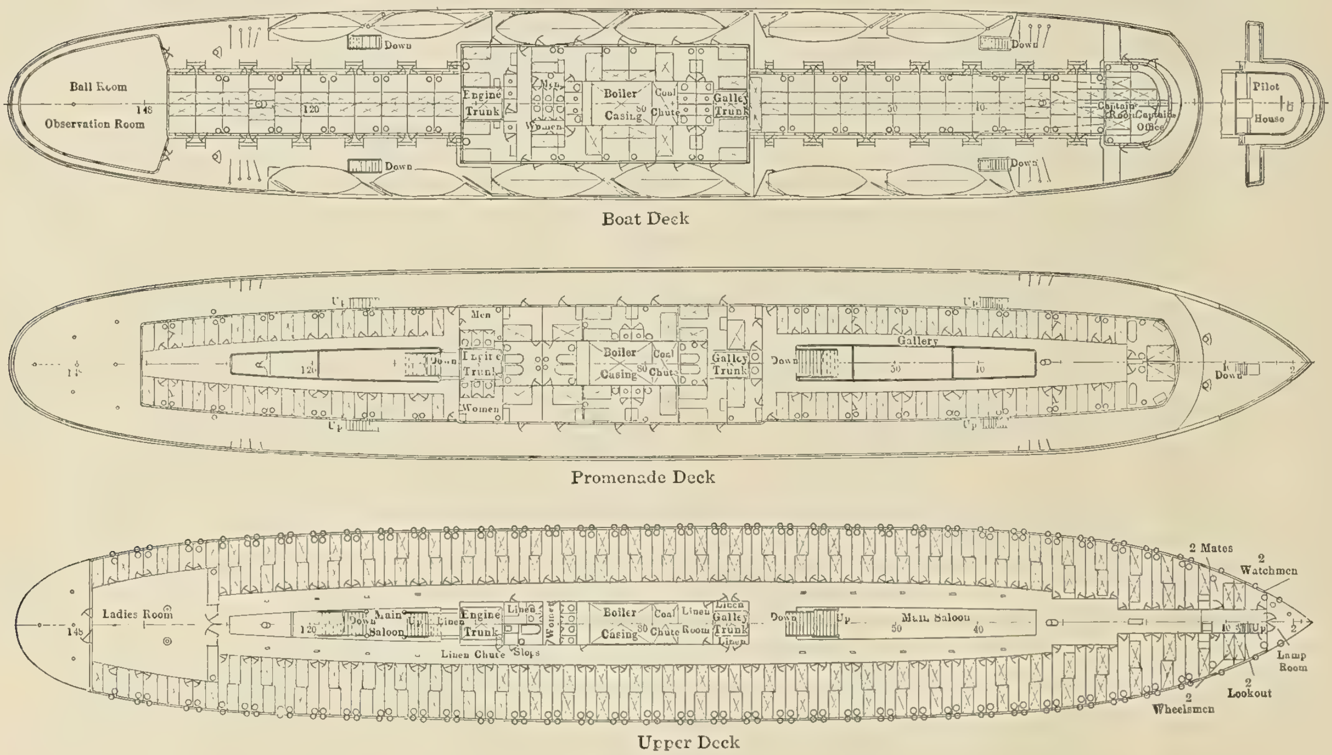


Fig. 8.—Deck Plans

Russian Merchant Marine.—According to Government statistics, the Russian merchant marine consists of 1,016 steamers of 487,000 tons; 52 motor vessels of 13,000 tons, and 2,577 sailing vessels of 257,000 tons. The fleets of the Black, Azof and Caspian Seas represent 40.7 percent of the total number and 47.4 percent of the total capacity. During 1912 and 1913 the largest Russian steamship companies made extensive purchases of new steamers, of which 75.7 percent were built in English yards. About two-thirds of Russia's foreign trade is carried over seas, but only about 12 percent is under the Russian flag. The slow growth of the Russian fleet is attributed in part by the *Daily Consular and Trade Reports* to the comparatively small returns from the industry and to the crowded condition of the dockyards with government orders. Of Russian sailing vessels, however, only about 3 percent are built abroad.

The American Floating Exposition.—A floating exposition that will introduce the products of American manufacturers to the merchants of the West Indies and South America, with the object of increasing trade with those countries, is being arranged by the American Trade Tour Company, 15 Maiden Lane, New York. The steamship *Kroonland,* an American-built ship flying the American flag, has been chartered for the exposition and will leave New York on October 14 for a tour that will extend over 120 days, visiting the most important ports on the east coast of South America. There will be accommodations on the steamer for 400 traveling salesmen, and space enough for the display of the manufactured products of several hundred concerns. At Buenos Ayres time will be allowed for the salesmen to visit Chili and points on the west coast.

Care of the Electric Plant on Board Ship

Faults in the Armatures of Dynamos —How to Find and Remedy Them

BY SIDNEY F. WALKER

A fault is the term used by electrical men to describe a source of trouble; something that either stops the apparatus working or causes it to work badly. The armatures of all dynamos, whether used as generators or motors, are the seat of frequent troubles. Probably faults in armatures are more prevalent than faults in all of the other parts of the apparatus put together. It is the armature that is doing the work, that is subject to all the strains—both electrical and mechanical—that is subject to wide changes of temperature, and so on.

The principal faults found in dynamo armatures are:

(1) A break in the circuit of the armature.

(2) A connection between two adjacent coils, or between two adjacent wires of the armature.

(3) A connection between one or more of the coils upon the armature and the core.

Fault No. 1 is perhaps the most serious fault of all, because it stops the working of the machine. With faults Nos. 2 and 3 the machine may go on working for a certain time and may even be made to continue working under special conditions, providing that it is understood the convenience will have to be paid for later on.

A break or a disconnection in the armature may arise in the middle of one of the coils, though it is very rarely that such a thing happens. When such a fault does occur it is a very troublesome one, because it is so very difficult to find and because the coil has to be taken right off for repair. The only case in which, in the writer's experience, such a fault has occurred has been where either inferior wire has been employed, where there has been a weld in some part of the coil, or where a joint has been made in the wire with which the coil is wound. Modern dynamo makers are very careful indeed as to the quality of the wire which they employ, and as to the firms whose wire they use; but with the very best firms and with the greatest amount of care it may sometimes happen that there is a weld in the wire, somewhere in the length of an armature coil. In the process of wire drawing welds are necessary. Experienced wire drawers make then as few as possible; but it may happen that a wire breaks in going through one of the draw plates, and rather than sacrifice the whole coil a weld is made, as carefully as possible, and after the wire has been covered with two coatings of cotton, the cotton being varnished or protected by one of the insulating materials upon the market, or even when the wire has been enameled, according to the latest method of insulating wires for electric magnets, it is practically impossible for the man who winds the coils to know of the existence of the weld. If the weld is properly made, probably it is as good as the wire itself. It will introduce a very small resistance into the circuit, and its presence might be suspected, by very careful tests, from this cause.

On the other hand, welding tends to make the wire brittle just by the side of the weld, and it may happen later on, when that particular portion of the coil is exposed to a considerable amount of heat, possibly followed by contraction, and again followed by heating up, that the wire may break just beyond the weld. It may also happen that by accident, or through shortage of wire in the works, together with pressure for delivery, two pieces of wire are jointed together to form a coil. This, of course, should not be done; but under pressure things of the kind often are done, particularly when repairs to machines are executed. The jointing process has the same tendency to render the wire brittle just beyond, and the same thing may happen.

But by far the most common cases of disconnection occur at the commutator; particularly after repairs have been executed. It will be remembered that the adjacent ends of two armature coils are connected together, and to a segment of the commutator. Sometimes there are arms standing up from the commutator, sometimes the wires are embedded in slots in the segments. With either method it requires considerable care and skill to make sure that the joint is a good one. The slot in which the wires are to be held should be carefully cleaned, all grease thoroughly removed, the slot itself thoroughly tinned, the ends of the wires thoroughly tinned and the whole bedded together with solder.

Another possible cause of disconnection is that the ends of the coils may be broken off between the armature and the commutator. This is due to various causes that have not been thoroughly investigated.

Both a connection between two adjacent coils or between two adjacent wires of the same coil, and a connection between any coil and the iron core, will lead to heating of the armature and to sparking. It may be taken as an axiom that when sparking increases the condition of the armature should be suspected. It may be due to the causes mentioned in the article dealing with sparking; but if, after applying the remedies mentioned there, sparking still continues, the armature should be carefully examined for heat. When the two wires, forming the ends of a coil, are connected together, that coil will heat up, and it will usually heat so badly that there is no question as to where the trouble is. When a coil is in connection with the iron core the heating will be less; but it will usually declare itself by heating up that particular coil to a certain extent and by increased sparking when that particular coil passes under the brush.

The cause of two wires forming the ends of a coil being connected together is very frequently at the commutator. If the commutator has been trued up, it may happen that very minute pieces of copper are left connecting two adjacent segments together. It has also frequently happened that when a commutator has been taken off to repair the armature and has been replaced, the two ends of one coil have been connected to the same segment of the commutator instead of the two ends of adjacent coils, as it should be.

The cause of a coil becoming connected to the core is usually a fault brought about during construction. The armature core is built up of a number of thin iron or mild steel plates, from which pieces have been punched out, the gaps so made together forming the channels in which the wires are laid when the armature is wound. Unless great care is taken it may easily happen that very small pin points of iron or steel are left sticking up, and with the increase of temperature to which the machine is subject when it is running and the vibration to which the armature is also subject, these pin points may work their way through the insulation and make connection with the inner coil.

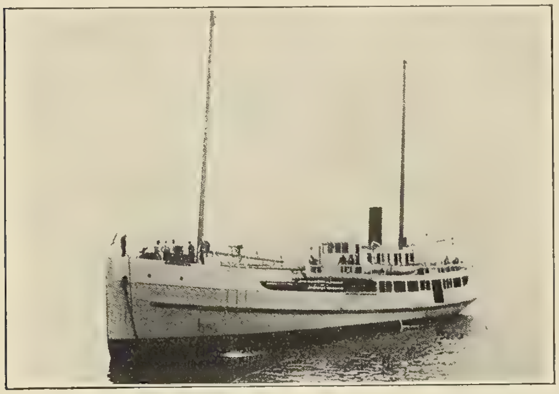
One connection between a coil and a core will not do a great deal of harm; it will merely give rise to heat, and possibly the machine may have to run a little faster; but two such connections may cause the machine to refuse to furnish its full pressure, unless driven at a very much higher speed than the normal; and it will lead to the development of a very large amount of heat in the coils between the two connections.

How to Find the Faults

A good deal may be done toward finding all the faults by carefully observing the sparking at the commutator. With a break in the armature circuit no pressure will be furnished, but there will be a small spark when the disconnection comes round to the negative brush in the case of the generator and the positive brush in the case of the motor. It is not always easy to locate the position of the spark, and therefore some kind of test has to be applied. The surest method is to make another break in the armature by disconnecting two ends of adjacent coils from their segment of the commutator and carefully separating them. Then by testing round with a small battery and either a galvanometer or a small cell-testing voltmeter, the break will be easily located. Having formed a testing circuit of the battery and the galvanometer or voltmeter, one end of the circuit is connected to one of the wires that have been disconnected from the commutator, and the other wire is touched on each segment of the commutator in succession. The galvanometer or the voltmeter will give a deflection at each segment until the break is passed. The break, however, may be found without disconnecting, by the aid of a telephone and a battery.

When the position of the disconnection is found—if it does not appear to be at the commutator itself, as mentioned above—that coil will have to be taken off, and it will probably be found that there is a break inside. The coil which is short circuited, between which connection has been made either by a piece of copper between the commutator segments or the equivalent, needs no testing. It shows by the heat in the coil itself; and the writer would like to give the practical hint that, after an armature has been repaired, if the commutator has been disconnected—even if only a portion of it has been—the armature should be run slowly, without any load, and the coils very carefully examined for heat. The heating will take place when the armature is run very slowly and without any connection to the outer circuit.

A connection between one of the coils and the core is also easily found by the aid of a battery and either a galvanometer or a testing voltmeter. A testing circuit is formed with the battery, the galvanometer or voltmeter and the two end wires. One of the end wires should be connected to the armature shaft, the brushes having been thrown back, and the other end wire touched on one of the commutator segments. If there is a connection between any of the coils and the core a deflection will be shown upon the galvanometer or voltmeter; and by passing the testing wire round the commutator, or what amounts to the same thing, by holding the wire in one position and moving the armature slowly round, the position of the coil connection will be found by the fact that, with a galvanometer, the deflection will be reversed.



Motor Cattle Schooner Vaquero

Motor Cattle Schooner Vaquero

One of the largest of this year's motor work boats on the Pacific Coast recently completed a successful trial trip at San Pedro, Cal., and is now in commission on the run between the Santa Rosa Islands and San Pedro. The name of the vessel, *Vaquero,* meaning "Cowboy," is quite appropriate, in view of the fact that she is primarily intended to be used as a cattle carrier on the run between San Pedro, Santa Barbara, and the Santa Rosa Islands, although she is well able to handle freight if desired.

This vessel was built by William Muller at the Banning Shipyards, San Pedro, Cal., for Messrs. Vail & Vickers, of Los Angeles. In general design she resembles the familiar class of steam schooners of the Pacific Coast, but in detail she shows a marked simplicity of finish, which, while extremely plain, is very effective and entirely different from that which has ordinarily been adopted by vessels built in the past. The *Vaquero* is 130 feet overall, with 29 feet extreme breadth and a draft of 10 feet. On the main deck and in the forward hold there is provided space enough to carry ten carloads of grown steers; in other words, about 250 head; or, instead, she can carry 1,200 head of grown sheep. She is completely fitted with staterooms for the officers, and has comfortable crew's quarters forward. Storage for two 18-foot boats is arranged for on the upper deck.

The main engine is a 250 horsepower four-cylinder Union, of the open crosshead type. Located on the main deck, in the forward end of the engine hatch, is the electric lighting and pumping set, which consists of an 8 horsepower double cylinder Union special electric engine, direct connected to a 4 kilowatt Crocker-Wheeler generator on one side, and a 4-inch by 4-inch Deane triplex fire and bilge pump on the other. A friction clutch is provided, which allows the pump to be thrown in and out of action at will. Overhead exhausts with mufflers will be used for the main and auxiliary engines; the mufflers being placed in a stack gives her the appearance of a steam schooner, and at the same time provides efficient ventilation for the engine room.

Deck Load of Cattle on the Vaquero

On the forecastle deck there is a Providence pump brake windlass, connected with a chain drive to a 16 horsepower, double cylinder Union hoisting engine, the messenger chain sprocket on the drum shaft being provided with a clutch so that it shall be disengaged when the hoist is being used for handling cargo.

Two fuel tanks with a total capacity of 4,200 gallons are located in the engine room. There are also two water tanks, each having a capacity of 950 gallons. One of these tanks is intended for ship's use, and the other to provide water used in the vaporizer of the main engine.

Messrs. Vail & Vickers are the owners of the power schooner *Santa Rosa Island,* which has been in commission for ten years. She has not sufficient capacity for present and future requirements, however, and the *Vaquero* has taken her place. The unqualified success of the *Santa Rosa Island* is,

doubtless, responsible for the installation of distillate engines in the larger vessel. In addition to the run of more than 100 miles into the open sea from San Pedro to the Santa Rosa Islands, the *Vaquero* will carry cattle and freight up and down the Meixcan coast.

Reconstruction of the Carolina

The steamship *Carolina*, of the New York & Porto Rico Steamship Line, arrived in the port of New York from Newport News, Va., on the afternoon of March 2, in many respects a new ship, having been reconstructed by the Newport News Shipbuilding & Dry Dock Company during the past nine and a half months, from plans and specifications prepared by Theodore E. Ferris, naval architect and marine engineer, of New York City, in collaboration with Mr. Franklin D. Mooney, vice-president and general manager, New York & Porto Rico Steamship Company. The reconstruction work was carried on under the supervision of Mr. Ferris.

It will be recalled that the *Carolina* was originally the *Grand Duchess*, built for the Plant Line as a twin-screw freight and passenger ship, and later owned by the Savannah Line and named *City of Savannah*. Following this she became the property of the New York & Porto Rico Steamship Company, and was named the *Carolina*.

Previous to her reconstruction she was operated on the Porto Rico line for a number of years, but was not wholly successful, as many repairs were necessary on almost every voyage to keep the vessel operating. Not only were the boilers deficient and worn out, but the propulsive efficiency of the vessel had always been deficient and inadequate, because of an abnormal bossing out condition about the stern in the original construction of the ship for the twin-screw arrangement. The time having come for reboilering the ship, renewing the tank top in the boiler space, and other miscellaneous work necessary, it was decided, after several conferences of the board of directors, headed by Mr. Mooney, at the recommendation of Mr. Ferris, to rebuild the ship, not only to make her efficient in regard to speed and economy of power, but in return increase her earning powers as regards increased deadweight cargo capacity and cubic capacity, reduction in crew and increased passenger accommodations.

After a thorough survey of the hull of the ship was made, the condition of the hull was found to be excellent, as there was practically no deterioration. Plans and specifications were prepared and a contract was placed with the Newport News Shipbuilding & Dry Dock Company for the reconstruction of the ship, changing her from a twin-screw to a single-screw vessel, and installing new boilers, new engines and auxiliaries. The work represented what is probably the most intricate and largest rebuilding proposition on any ship done in this country, reflecting great credit on the part of the owners in undertaking such a proposition, which has resulted in now making this vessel a complete commercial success.

The *Carolina* before being altered to a single-screw ship was equipped with twin-screw quadruple-expansion engines, developing, collectively, about 7,000 indicated horsepower, two 16-foot diameter double-ended boilers and two 16-foot diameter single-ended boilers, fitted with forced draft. Her speed on the Porto Rico route was nominally 13½ knots; but the vibration, steering and handling qualities of the ship were not good.

The altered single-screw arrangement consists of one triple-expansion engine, with cylinders 31 inches by 50 inches by 34 inches, and a common stroke of 54 inches, and four single-ended boilers 16 feet in diameter, developing 4,000 indicated horsepower, which will give her a speed of 14½ knots on the Porto Rico route. On her sea trial on the trip from New port News to New York, with 1,100 tons of water ballast and coal, the ship developed on a four-hour run a speed of 16¼ knots; there was little or no vibration; the ship steered and handled perfectly, and showed exceptional seagoing qualities in the snowstorm and gale off the Atlantic coast on the night of March 1, a storm which delayed a number of incoming transatlantic vessels.

In the process of reconstructing this ship there has been gained, including the actual weight due to the reduction in the weight of the propelling machinery, reduction in bunkers and boiler feed-water, about 1,000 tons in deadweight, 35 percent in cargo cubic capacity, and quite an increase in passenger accommodations, the number of staterooms, suite rooms, private baths, etc., a reduction in the engine department crew and a vast reduction in coal consumption, all principally because of the ship's original abnormal condition at the stern around the propeller wheels. This is due to the change to a single screw, which makes her propulsive efficiency high and the necessary horsepower to obtain the desired speed vastly less than was originally required for the ship. The *Carolina* is of the following dimensions:

Length over all	405 feet
Length between perpendiculars	379 feet
Depth to hurricane deck	36 feet 7 inches
Beam, molded	47 feet 8 inches
Total deadweight at maximum load draft, including cargo, coal, water and stores	5,100 tons
Cargo, cubic capacity	260,000 cubic feet
First class passengers	190
Second class passengers	50
Crew, about	100

There are a number of suite rooms and private baths and public spaces about the ship, such as a smoking room, social hall, observatory, deck shelter, ladies' parlor, etc., which are elaborately finished. The dining saloon is a spacious and luxurious room, with the modern arrangement of small tables. The catering will be of the popular hotel service. Additional shade decks and awnings have been fitted, and the ship is equipped with boats with capacity for every person on board.

The *Carolina* has complete new propelling machinery of the very best construction, a thoroughly stanch hull with complete double bottom, numerous watertight bulkheads and other safety devices, all combining to guarantee the *Carolina* a high position among steam craft. The ship is commanded by Capt. J. O. Foss, commodore of the Porto Rico line. Mr. Stewart Holmes, who for several months has been at Newport News with the ship, acting as inspecting engineer, will be chief engineer of the vessel.

Monthly Shipbuilding Returns.—The Bureau of Navigation reports 68 sail and steam and unrigged vessels of 15,116 gross tons, built in the United States, and officially numbered during the month of February. Two of these were steel steamships, aggregating 8,834 gross tons, both of which were built on the Atlantic coast, the largest being the tank steamer *John D. Archbold*, of 8,374 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Standard Oil Company, of New Jersey.

National Association of Engine and Boat Manufacturers.—At a meeting of the Exhibition Committee of the National Association of Engine and Boat Manufacturers, Incorporated, held in New York, March 20, the following officers were elected for the ensuing year: President, John J. Amory, of the Gas Engine & Power Co., and Chas. L. Seabury & Co., Cons.; first vice-president, Henry R. Sutphin, of the Elco Company; second vice-president, W. H. Mullins, of the W. H. Mullins Company; third vice-president, Charles A. Criqui, of the Sterling Engine Company; treasurer, James Craig, of the Craig Engine & Machine Works.

British-Built Destroyers for the Greek Navy

Description of Four Powerful Destroyers Built Originally for the Argentine Government But Subseqently Acquired by the Royal Hellenic Navy

BY F. C. COLEMAN

The outbreak of war in the Balkans in the autumn of 1912 found both sides lamentably unprepared as far as their naval resources were concerned. Bulgaria's available force amounted to perhaps ten small steamers of no real value and three 100-ton torpedo boats built in 1907. Servia, of course, has no navy, while the Greek Government possessed one fairly modern armored cruiser, the *Giorgios Averoff,* of 10,000 tons, built at Leghorn, and three ancient ironclads. These were supplemented by eight destroyers, built in 1906, four of the *Sphendoni* class, built by Yarrow, and four of the *Doxa* class, built by the Vulcan Company, which were originally fairly fast vessels of about 360 tons. Turkey possessed two ancient ironclads purchased from Germany, and two still more ancient vessels that had undergone reconstruction about eight years ago. Besides these she had two fast cruisers, the *Hamidieh* and *Mejidieh,* of 3,500 tons, built at Armstrong's and Cramp's, and two torpedo cruisers of 750 tons, built at Kiel. The Turkish torpedo flotilla consisted of four powerful 620-ton destroyers, purchased three years before from Germany, four 280-ton boats built in 1908, and eight or ten older boats. So far the balance of naval power, as far as ships went, seemed to lie with Turkey.

The decision of the Balkan League to attack Turkey was made in ample time for either Bulgaria or Greece to have acquired more ships, but such a purchase was eventually left till almost too late, although the question had been under discussion many months before. In July, 1912, however, with the object of strengthening its destroyer flotilla, the Greek Government purchased the then nearly completed destroyers *V* 5 and *V* 6, which were under construction at the Vulcan Company's works at Stettin for the German Government. These vessels now appear in the Greek navy as the *Neagenea* and *Keraunos*. They are of 700 tons displacement and about 32.5 knots speed. Slight alterations to the vessels' armament were made to suit their purchasers, the gun armament being increased to four 23-pounders in place of the German two. These vessels arrived in Greece in September, 1912, and saw a considerable amount of war service for several months.

In addition to these two ships the Greek Government, which had, early in the year, commenced pourparlers with the object of purchasing the destroyers building by Cammell, Laird & Company, Ltd., for the Argentine Government, eventually decided definitely to acquire them. These four vessels formed part of a programme of twelve destroyers ordered in pairs early in 1910 from two German and two French firms and from Cammell, Laird & Company, Ltd., of Birkenhead, who were entrusted with four boats, and at whose request the Argentine Government consented to annul its contract with them.

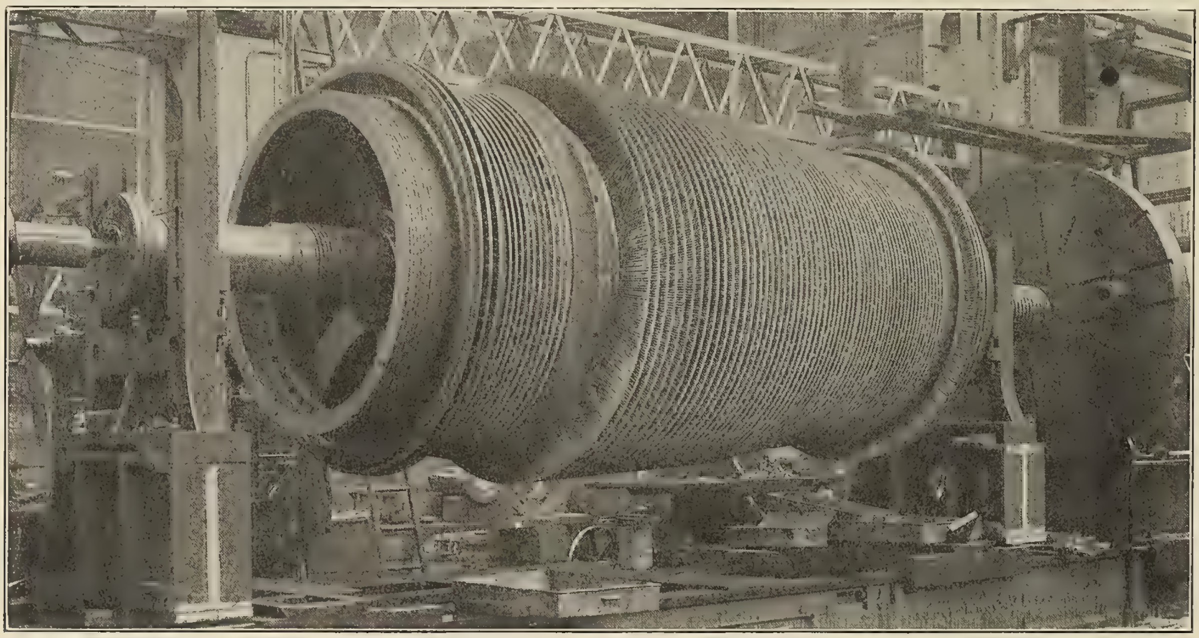


Fig. 1.—Turbine Rotor in Lathe, Showing Blading

The four ships, now known as the *Lion, Eagle, Hawk* and *Panther,* are large and powerful vessels of somewhat special design. Their length on the waterline is 285 feet, beam 27 feet 8 inches, and draft of water about 9 feet, the propellers, however, projecting considerably below this. At this draft their displacement is about 1,050 tons. The designed speed of 32 knots was slightly exceeded on trial. They are in consequence somewhat between the ocean-going destroyers of five years ago and the latest British Admiralty vessels.

A radical difference, however, lies in the arrangement of the machinery, the armament and the general equipment, all of which embodied features seldom met with in this class of ship. The propelling machinery consists of two separate and independent steam turbines in two compartments separated by a transverse bulkhead. The combined power developed on trial was about 22,000 shaft horsepower, the turbines running at 620 revolutions.

The design of the turbines embodies a high-pressure impulse wheel mounted at the forward end of the drum,

whereon are also mounted about sixty rows of the ordinary Parsons blading. The turbine cylinders are of cast iron.

Steam is supplied by five boilers of the White Forster type, the pressure being 230 pounds. The total heating surface is about 27,000 square feet. Each boiler is in a separate compartment. Fore and aft bulkheads run the complete length of the engine and boiler rooms, forming side bunkers along the skin of the ship, and transverse coal bunkers are fitted opposite boilers 1 to 4.

No. 4 boiler is oil-fired and has a heating surface of 8,500 square feet. The total coal bunker capacity is 230 tons, with about 90 tons of oil, which is carried mostly in two main tanks at the ends of the vessel.

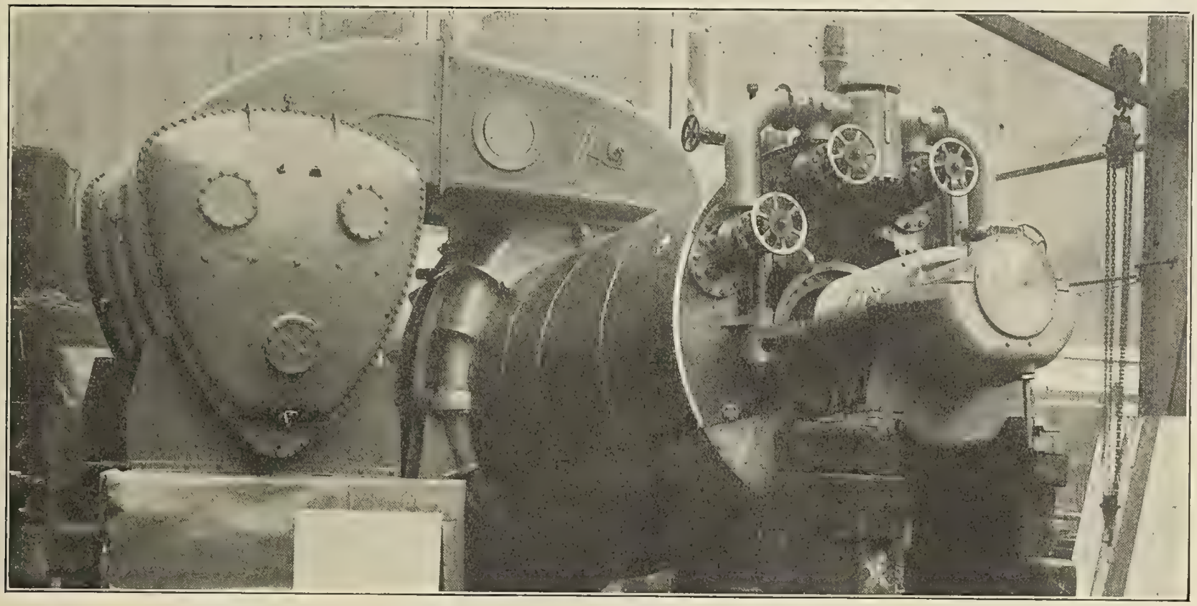


Fig. 2.—Turbine and Condenser Assembled

The arrangement of bulkheads and coal bunkers adds enormously to the safety of the ship in the event of damage, and greatly assists in the protection of the boilers in action. While this renders the hull construction of these destroyers excellent from the point of view of safety, the multiplicity of compartments does not facilitate supervision. Two fan engines are fitted in each stokehold, and each boiler has one main and one auxiliary Weir feed pump.

Two oil fuel pumps, delivering oil through a boiler of large dimensions, supply the oil boiler. Each boiler is fitted with separate feed heater. The remainder of the auxiliary machinery is of a comprehensive character.

In each engine room "Uniflux" condensers and a Weir "Dual" air pump maintain a vacuum of 28 inches when the vessel is running at full power. The two evaporators have a combined output of 40 tons per day. A 50-ton fire and bilge pump is placed in each engine room. The steering engine is placed in the after engine room. Bilge ejectors of high capacity are fitted throughout in each main compartment. The engine room ventilation is secured by means of electric fans.

The steam dynamos are situated in a spearate compartment aft of the main engines. The latter are of the A. E. G. turbine type, and supply all the power for ship lighting and for the two searchlights. For harbor use an oil-driven dynamo is placed in the forward auxiliary machinery compartment, where also are situated the forward air compressor and the ice-making plant, which is also arranged for magazine cooling purposes in conjunction with the thermo tank ventilators, which are also arranged for cabin and crew ventilation. The after air compressor is situated in the dynamo room. Both are of Whitehead design.

The armament consists of four 4-inch high-velocity guns, designed and supplied by the Bethlehem Steel Company, who, it will be remembered, supplied the armament for all the vessels built for the Argentine Government under their 1910 programme. The guns are of a heavy and powerful type, using fixed ammunition with a long pointed shell of 31 pounds and nitro-cellulose powder. The muzzle velocity is

Fig. 3.—One of the 32-Knot Destroyers Built in England for the Greek Navy

3,100 foot-seconds, and the range at 5 degrees elevation 7,970 yards. At just over 9 degrees the average range of twelve shots proved to be 10,768 yards. The Bethlehem "two-hand" elevating and training mechanism is fitted, as well as the company's "Rock Bar" cross-connected sights. Ammunition hoists, operated by electric motors, are fitted to both magazines, alternative hand gear being provided.

The torpedo armament consists of four 21-inch tubes of Whitehead Fiume design. Spare torpedo boxes are carried on the upper deck in close proximity to each tube, and are so placed as to permit of the tubes being reloaded with the spare torpedoes without lifting being required, as the boxes are adjacent and in line with the fore and aft position of the tubes.

The crew of 90 men, including petty officers, are berthed forward on two decks. A sick bay is provided, but seems an unnecessary refinement in view of the probable frequent presence of the almost essential parent ship. Elaborate ventilating arrangements—hot and cold air—are supplied throughout. Aft are found the wardroom, the captain's day and night cabins and private bath room, and five other two-berth cabins for the officers, who also have a bath room provided.

An elaborate system connects all the compartments, and is also fitted to the gun and torpedo tube positions. The wireless telegraphy installed has a range of 250 miles. It receives current through a converter run off the main lighting circuit. Four boats are provided—two dinghies, one whaler and one motor boat.

The general appearance of the vessels is not enhanced by the adoption of one funnel to each boiler. With the side torpedo tubes and boxes and the numerous array of stokehold cowls their appearance is a distinctly heavy one, and a better looking ship would have been obtained with three funnels. As is so often the case with minor navies, the attempt appears to have been made to embody too much in one design, though this can hardly be attributed to the builders, who appear to have fulfilled the exacting conditions laid down by the Argentine authorities, though without much to spare. That the boats have acquitted themselves well under service conditions is a tribute to their reliability and strength of construction, for all four have been constantly at work.

Prior to the purchase of these vessels the Greek Government placed orders in Germany for half a dozen 125-ton torpedo boats of 25 knots speed, which are expected to be delivered this year. If, as certainly appears to be the case, the *Lion* class destroyers are too large and too costly for the Greek service, it may reasonably be imagined that torpedo boats like these are too small, and that a better design altogether for their purposes would have been a boat of between 400 and 500 tons, somewhat on the lines of an improved *Sphendoni* type.

Pier Construction at Baltimore.—Prior to the Baltimore fire in 1904, that city owned practically none of its water front, and municipal water front development was slow and expensive. After the fire, however, steps were taken toward a definite policy under the direction of the Burnt District Commission, and $10,000,000 (£2,040,000) was raised, part of which was available for pier construction. Eight municipal piers, 200 feet wide and varying in length from 551 to 1,450 feet, have been built, and another is under construction.

Pontoon Barge Built on the Isthmus.—The largest vessel ever built on the Isthmus of Panama is a pontoon barge 378 feet long, which is soon to be launched. Seventeen shipwrights and sixteen calkers were brought from shipyards on the North Atlantic Coast of the United States for the construction of this barge, while eighty-seven negro helpers were recruited from the regular forces of the Canal Commission.

International Engineering Congress, 1915: The Section of Naval Architecture and Marine Engineering

BY PROF. W. F. DURAND*

Readers of International Marine Engineering and engineers generally are already informed of the fact that it is planned to hold in San Francisco in 1915, in connection with the Panama-Pacific Exposition, a general international engineering congress to which engineers throughout the world are invited, and to the transactions of which it is planned to obtain the most eminent engineers in the various subjects as contributors, either as authors of papers or of discussions.

This congress is held under the auspices of the five oldest national engineering societies, viz.: the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers and the Society of Naval Architects and Marine Engineers, and the work of organization and management is in charge of a general committee representing these five societies.

It is planned for the papers in general that they shall be of such a character as to give a summarized view of the recent progress, present status and trend of progressive practice in the various lines of engineering activity, and thus present, in a wide and comprehensive view, a summary of the world's recent progress and present status in all important fields of engineering work. It is believed that papers dealing with specific problems or particular and individual pieces of engineering work may more suitably find their place in the annual proceedings of the various engineering societies, and that the occasion of a great engineering congress furnishes an appropriate opportunity for the rounding up of a practice and progress throughout the past decade and the taking of stock in matters of present status and tendency.

The general field of engineering work for purposes of the congress is divided into eleven sections, as follows, and it is planned that in the main there will be a volume of transactions for each section. The plans of the sub-committee on papers have now developed to such a point that it is possible to place before the readers of International Marine Engineering a comprehensive outline of the papers proposed for the section of Naval Architecture and Marine Engineering. The papers are twenty-two in number, with titles and condensed outline of treatment as follows:

Syllabus

(1) *Naval Architecture, Ship Calculations, Resistance and Propulsion*—Under this topic it is desired to note the important lines of advance in:

1. Static theory and problems with special reference to the various ship calculations, stability methods, treatment of special problems, as, for example, stability under damaged conditions or with liquid cargo, etc., etc.

2. Dynamic theory and problem, with special reference to the important advances which have been made by experimental methods in matters connected with the resistance and propulsion of ships and in the study of special problems, such as the resistance of submarines or of other special forms, of appendages, the influence of form characteristics on resistance, the best characteristics for propellers of low pitch ratio for direct connection to turbines, etc., etc.

(2) *Large Passenger Liners*—This topic is intended to cover in a comprehensive way the advances which have been made during the past decade in the characteristics of ocean passenger liners, with special reference to size, strength, peculiar structural features, speed, carrying capacity, general

*Chairman of the committee of management.

accommodations, propulsive and auxiliary machinery and safety, with due regard to the more specialized treatment of this subject, under topic No. 16.

(3) *Ocean Freighters*—This topic is intended to cover for this class of ships the progress made during the past decade and the present status in matters relating to size, speed, cargo capacity, structural characteristics and safety, with due regard to the more detailed treatment of this subject under topic No. 16. In this paper the subject of cargo-handling devices need only be given incidental reference. See topic No. 11.

(4) *Passenger and Freight Steamers for Service on the Pacific Ocean*—This paper is intended to give a comprehensive resumé of recent practice in the design and construction of steamers for service on the Pacific Ocean and including the use of oil fuel. The paper will include due reference to size, speed, power, cargo and fuel capacity, special structural features, propulsive machinery, etc., with special reference to the conditions imposed by transpacific service. The subject of safety should be treated with due regard for the more detailed consideration of this subject under topic 16.

(5) *Great Lakes Freighters*—This topic is intended to cover for this type of construction the recent progress and present status in matters relating to size, carrying capacity, speed, propulsive machinery, auxiliary equipment, strength and principal structural characteristics. The subject of cargo handling need be given only incidental reference. See topic No. 11.

(6) *Yachts and Pleasure Craft*—This topic is intended to cover for this general type of construction the recent progress and present status in matters relating primarily to size, speed, accommodation, cruising radius, strength, structural characteristics, propulsive machinery and auxiliary equipment and safety, with due regard to the more detailed treatment of this subject under topic No. 16. This subject is intended to include the use of the internal-combustion engine as a prime mover for all types of pleasure craft and with special reference to the field of the motor boat.

(7) *Light Draft Sound and River Boats*—This topic is intended to cover for this general type of construction the recent progress and present status in matters relating to size, capacity, speed, propulsive machinery and auxiliary equipment, strength, peculiar structural features and methods of cargo handling peculiar to the type of boat.

(8) *Warships of First Line Battle*—This topic is intended to cover for the general fighting unit of the first line of battle the recent progress and present status in matters relating to size, speed, cruising radius, propulsive machinery and auxiliary equipment, strength, peculiar structural features and safety, with due regard to the more detailed treatment in paper No. 16. The subject of armament, offensive and defensive, should be covered in a broad manner and with regard to the more detailed treatment which is to be given to these subjects under topics Nos. 18-21.

(9) *The Torpedo Boat, the Destroyer and Cruiser Destroyer Types*—This topic is intended to cover for this class of construction the recent progress and present status in matters relating to size, speed, cruising radius, propulsive machinery and auxiliary equipment, peculiar structural features, strength and safety, with due regard to the more detailed treatment of this subject under topic No. 16. The general subject of armament, offensive and defensive, should be covered in a broad manner and with due regard to a more detailed treatment of these subjects under topics Nos. 18-21.

(10) *The Submarine*—This topic is intended to cover for this type of construction the recent progress and present status of matters relating to size, maximum depth of operation, maximum time of immersion, cruising radius, speed on the surface and immersed, leading structural features, propulsive machinery, auxiliary equipment, navigational appliances for use when immersed, armament, offensive and defensive, with due regard to the more detailed treatment of these subjects under topics Nos. 19-21.

(11) *Cargo-Handling Methods and Appliances*—This topic is intended to cover in a summary manner the general subject of cargo handling, both from the dock to the ship and the reverse, and by means of equipment located both on the dock and on the ship. The space available will require limitation to the important lines of progress during the past decade and the present most approved devices and methods. It will naturally cover the field of dock cranes, stationary and traveling, ship hoists of various types, size and arrangement of hatches, and other features bearing on the same general problem.

(12) *Fuel Oil*—This topic is intended to cover the important lines of progress during the past decade and the present most approved practice in connection with the marine uses of fuel oil. The discussion will naturally include atomization by means of air and the recent advances which have been made in atomization by mechanical means, together with suitable mention (having due regard of their relative importance and function) of the general items of a complete oil-burning installation for marine use. If practicable, the papers should include economic results showing the status of oil burning as a factor in the economy of ship operation.

(13) *Application of the Steam Turbine to Marine Propulsion*—This topic is intended to cover the recent practice and a broad view of the present status of the general use of the steam turbine as a prime mover for ship propulsion. The treatment will naturally include the use of turbines by direct drive to the propeller, through mechanical speed reduction, or through speed reduction by the use of an electric generator and electric motor as intermediate links; also combinations of turbines and reciprocating engines with regard to various purposes and for special types of service. Advantages and disadvantages, limitations and economic results should naturally receive due attention in the general treatment of the subject.

(14) *Application of Diesel or Heavy Oil Engines to Marine Propulsion*—This topic is intended to cover the remarkable progress in the application of this type of prime mover to the demands of marine service which has characterized the last decade. The paper will naturally include reference to size of ship, power and weight of propulsive machinery, revolutions, methods of starting and reverse and other special characteristics required for marine use. An important section of the general subject relates to the question of reliability under the conditions of marine service, the cost of up-keep and general reliability and availability as compared with steam prime movers. The best thermal efficiency of the Diesel engine and of engines of this type is well known. It is very desirable, however, that some information should be given, if practicable, regarding fuel economy under general service conditions.

(15) *Marine Boilers and Boiler Room Equipment.*—This topic is intended to cover the important lines of progress and the present most approved practice with regard to the design, installation and operation of boilers and boiler room equipment. From the nature of the subject, the treatment need not be exhaustive and will naturally cover only the important lines of progress during the past decade. The treatment of the topic will naturally include references to advancing steam pressures and their influence on design, operation and maintenance; to the use of the firetube boiler, as, on the whole, distinctive of mercantile practice, and of the watertube boiler as still more definitely distinctive of naval practice, and to the extent to which the latter type has gained acceptance in the mercantile field; to superheating and the use of superheated steam; to methods of mechanical draft, of feed-water supply, of the handling of ashes and refuse, of the handling of coal

from bunkers to furnaces, of clock-regulating firing, of special developments relating to corrosion and deterioration, of improved methods of air supply and baffling, of the application of flue gas analysis and other features having reference to improved economy or control of boiler room conditions.

(16) *Safety at Sea*—This topic is intended to cover in a summary manner the more important matters relating to safety at sea, with note of the important lines of progress during the past decade. The paper will naturally be divided into a discussion of those factors which relate directly to the safety of the ship as such, and means for the saving of life in case of accident rendering the ship no longer seaworthy. Under the former head reference will naturally be made to the International Conference on this subject recently held in London and to the discussions and recommendations resulting therefrom. Under the latter head reference will naturally be made to the various auxiliary and secondary means, including lifeboats, liferafts, wireless telegraph equipment and other means of signaling, searchlights and other means for the detection of icebergs or derelicts at a distance, etc., etc.

(17) *General Problem of Naval Warfare*—This topic is intended to cover a discussion on broad lines of the general problem of naval warfare, including reference to the function of the various fighting units, battleships of the first line, battle cruisers, destroyers, torpedo boats, submarines, etc.; questions of the relative importance of weight of fire, speed and endurance; special combinations of characteristics in the various fighting units; distribution of offensive and defensive features, etc., etc.

(18) *Marine Gun Armament*—This topic is intended to cover recent progress in and the present status of modern marine gun armament in the various types, With reference to the typical heavy gun, the treatment should include a discussion of the features which have brought about so complete a change, and with such relative suddenness, from guns of about 12 inches caliber to those of 14 inches or more; likewise due consideration of the problem of massing and handling two or more such guns in turrets, and such further treatment of the turret as may be necessary for the main purposes of the paper, but without detailed consideration of the turret covering, as armor plates. (See topic No. 21.) The treatment should also include due reference to the problems of handling, recoil, control, erosion and other characteristic features of modern heavy, high-powered guns.

Gun armament of the intermediate and light caliber, and all types of quick and rapid-firing guns, may be treated in the same general manner, including due reference to the characteristics, capabilities, effective life and performance of the various classes of such armament.

(19) *The Marine Torpedo*—This topic is intended to cover recent progress in and the present status of the automobile torpedo as a weapon of offense. Improvements in motive power, in methods of launching, in directive control, in length of range and in character and power of explosive charge will naturally form the principal items of the treatment.

(20) *The Projectile*—This topic is intended to cover the recent progress in and the present status of the projectile used in marine guns of various types, but with special reference to those for heavy armor piercing service. The paper will naturally include a discussion of the contest between the armor plate and the projectile, and of the possibility of carrying charges of high explosives through modern armor and of exploding them in the inside, and of the problems of fusing and of projectile design and manufacture which these requirements entail.

Due reference should also be made to standing and r. f. ammunition for various types of gun and various demands of service.

(21) *Defensive Armor*—This paper is intended to cover the general field of defensive armor, its technical characteristics, its capabilities for stopping or breaking up modern projectiles, its distribution on shipboard on ships of the various types, improved methods of fabrication, improved forms and methods of backing, of attachment to the ship, etc.

(22) *Modern Naval Target Practice: Methods and Results*—This paper is intended to cover the astonishing advances which have been made in recent years in the methods and results of modern target practice.

The paper will naturally include reference to methods of gun and turret handling, of sighting, of fire control, of drill with stub and full caliber practice, with results as shown by recent records.

Of these various topics, Nos. 18, 19, 20, 21 and 22, relating to naval armament, must necessarily be treated with the reserve as to detail characteristic of such matters. The committee hopes, nevertheless, to obtain on broad lines an interesting and valuable summing up of recent progress and present status in these important lines of engineering work.

In addition to the regular ten volumes of transactions containing the professional papers and discussions, and which it is planned to publish in the standard 6-inch by 9-inch size, and of about 500 pages each, there will be published a somewhat smaller volume as to number of pages and containing all general proceedings of the Congress, together with a full index and carefully prepared digest or abstract of all papers published in the ten volumes of transactions.

Engineers and all who are interested in engineering work are invited to become members of the Congress. It is hoped, of course, that a very large number of those subscribing to membership will be able to attend the Congress in person, but such attendance is not to be considered as in any way necessary as a condition of membership. The membership fee has been placed at $5.00 (1/0/10), which will entitle the subscriber to the general proceedings and index digest volume, together with any other single volume of the transactions according to choice, and to the right to purchase additional volumes at a reduced price, varying with the number ordered.

The opportunity thus presented for engineers to acquire, at the minimum cost, a series of volumes dealing in this authoritative manner, with the various leading branches of engineering work, is one which those interested in such work cannot afford to overlook.

Circulars giving further detailed information, together with blank forms for membership application, will be gladly sent on application to the secretary, Mr. W. A. Cattell, 418 Foxcroft building, San Francisco, Cal.

A Large Floating Dock Built in England for Argentina

In connection with the rapid development which the Argentine Republic is effecting in connection with its sea-going interests, an excellent example of floating dock has recently been constructed by Messrs. Vickers, Ltd., of Barrow-in-Furness, to the order of the Argentine Government.

This dock is shown in Fig. 1, illustrating its sea passage under tow, and in Fig. 2, which shows it engaged in docking a steamship. It is of the box or solid type, the principal dimensions of which are as follows:

Length overall	300 feet
Extreme breadth	60 feet
Width between walls	43 feet
Depth from the top of the wall to the bottom	28 feet 4 inches
Depth of pontoon	6 feet 11 inches

The dock is designed for lifting vessels of about 1,500 tons displacement and on its trials it was found that the dock lifted a vessel of this weight in no less than 100 minutes from the

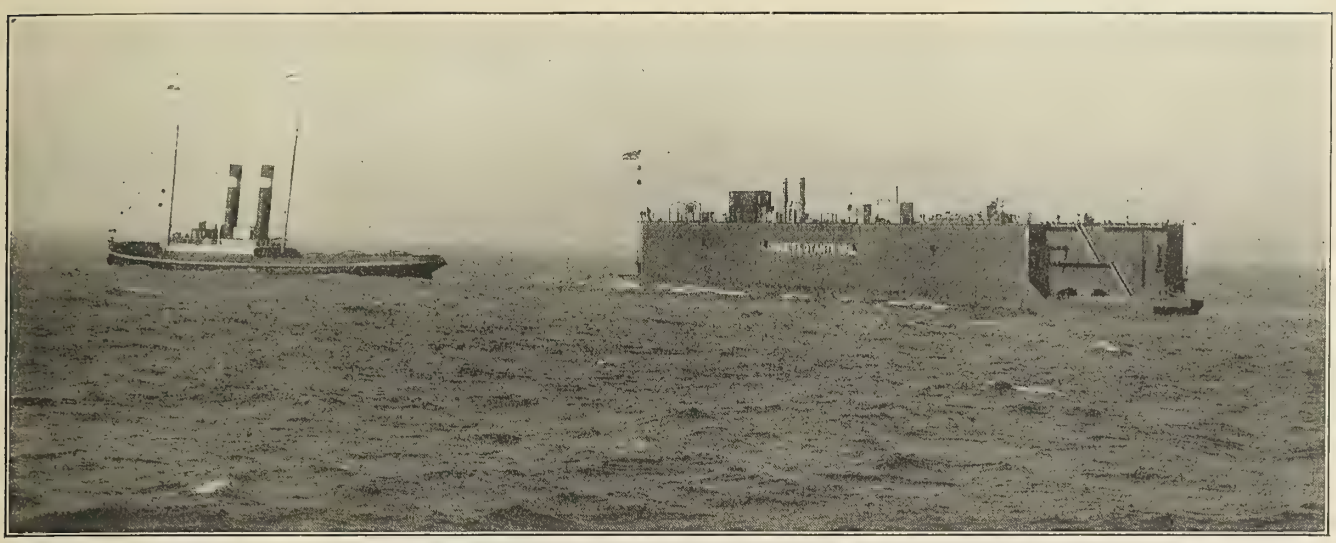


Fig. 1.—Argentine Floating Dock Being Towed to Its Destination

time that the vessel touched the keel blocks until the pontoon of the dock was clear of the water.

The dock is subdivided into 18 watertight compartments and a branch is led from each of these compartments to the main drain. In this way a single complete pumping installation is fitted throughout the dock. The pumping machinery consists of two centrifugal pumps driven by single cylinder engines placed in a compartment below the top deck in one of the walls. The control of the dock is centralized in a valve house, from which point the dockmaster has control of all the valves, engines, etc., throughout the dock. The lighting of the dock is effected by electricity throughout and means are provided for supplying current for lighting purposes of any vessel which may be at the time in repair at the dock. Electric fans are also provided for ventilating the engine and boiler-room.

Mechanical side shores operated from the top deck are fitted for steadying the vessel in position on the deck during the time that repairs are being effected, and in order to facilitate speedy repair work a steam traveling crane is fitted on one of the walls. At one end of the dock there is a gangway ir order to provide communication between the two side walls and

Fig. 2.—Steamship Docked in New Argentine Dock

means are provided by which the dockmaster in the valve house is kept continually informed of the amount of water in each watertight compartment.

The Control of Electric Motors on Warships*

BY C. L. PERRY

The use of electric motors on shipboard in the United States, if we neglect certain equipments which were in the nature of experiments, began with the equipment of some 8-inch ammunition hoists on the battleships *Indiana, Massachusetts* and *Oregon* about the year 1894. Since that time the use of electric equipments on naval vessels has steadily increased, until to-day they have almost supplanted steam for every purpose except engine-room auxiliaries and actual propulsion, and even the latter is being seriously considered. The number of installations on merchant vessels flying our flag has been insignificant compared with the number in the Navy, and in this article only the latter will be considered in detail.

As a result of naval influence nearly all marine control equipments are of special character embodying features rarely called for in industrial practice, and in point of safety distinctly in advance of the latter. The two most important general requirements for continuously-running motors are, first, no-voltage protection for all size of motors; and, second, the requirement that unless starting rheostats are designed with practically continuous capacity, the control equipment must be such as to render it impossible to leave the motor running with resistance in circuit with it. Water-tight and flame-proof covers are also required in many places.

In order to meet the no-voltage and resistance requirements it has frequntly been found better to use separate overload circuit-breaker panels with contactors mounted on them for no-voltage protection, connected with drum controllers having special contacts for the operation of the latter. The latest of these controllers have hinged handles which have a slight vertical movement as well as the usual rotary movement. The vertical movement operates a contact which closes the energizing circuit of the contactor, the main contacts of the latter being in circuit with the motor. In case the handle is released before the running point of the controller is reached, or in case of no-voltage, the contactor opens and cannot be closed until the handle is returned to either the "off" or first position.

Aside from these general special requirements the many unique uses of motors, such as training and loading the guns, forced draft blowers, steering gears, etc., require special features. Some of these will now be considered in greater detail.

Turret and Ordnance Control Equipment

In a turret the guns are controlled in a horizontal plane in pairs by the rotation of the turret, though their range may be separately adjusted by the elevating motors. In some of the turrets recently designed, the ammunition is first hoisted from the lower handling room in the magazine to an intermediate compartment; and there slid from the ammunition car of the lower hoist to the car of the upper hoist, which is then raised to the breech of the gun. This arrangement has been adopted on account of the danger of burning powder bags or other materials falling down into the magazine when a through passageway exists; although this danger is sometimes avoided by having doors in the passageway which close automatically.

Three different methods of control have been used successfully for ammunition hoists, each being a step in the development of this class of apparatus. The first was a dial-type controller arranged for dynamic braking in lowering; and the second was a plain drum controller for a shunt motor arranged so as to give power as well as dynamic braking in lowering the car. In one system, during lowering, a resistance —part of which is used during hoisting—is connected across the line, and the motor armature is then connected across sections of this resistance so as to gradually increase the potential across it. Such equipments are in use on a great many of the older vessels, which were furnished with a single hoist from the lower handling room to the gun. Their chief limitations were that the amount of current which could be handled greatly limited the speed of operation; and that it was difficult to locate a large drum controller beneath the gun-room deck, and still be able readily to operate it.

In the U. S. S. *Michigan, Florida* and *Utah,* systems of automatic control with master controllers, magnetic switches and limit switches were developed. The limit switches are so designed that the carriage is slowed down and stopped without any attention on the part of the operator. This is necessary on account of the extremely rapid operation required, the trip from the lower to the upper handling room usually taking from five to eight seconds, according to the height of the turret, and the trip to the gun taking about seven seconds, the latter depending slightly on the elevation of the gun. On these ships it was considered desirable to retain current on the motor as long as the car was up, and compel it to follow the motions of the breech, which introduced several additional complications. On some of the latest ships automatic electric control has been abandoned in favor of clutches driven by electric motors, the change being made for sake of simplicity. This method also overcomes, to a considerable extent, the trouble sometimes experienced with the slacking of hoist cables caused by motor armatures not stopping quickly enough; as the latter, on account of their high momentum, are difficult to stop accurately in a short space of time.

The next apparatus to consider is the rammer. This may be either of the telescope or the chain type. The former, as the name indicates, consists of a series of concentric tubes which are extended by means of an arrangement of chains and pulleys. The chain type consists chiefly of a large block chain, the links of which have square corners on one side so that they can bend in only one direction. Both types are usually driven by a compound wound motor, and except in a few recent ships no attempt at automatic control has been made, the operator being relied upon to check the speed as desired. In some special cases, however, automatic rammers have been used with very satisfactory results. In these a limit switch controlled through the agency of differential gearing jointly by the controller and the motor was used. The length of the rammer stroke could then be controlled by the position of the controller handle—a desirable feature when it is appreciated that the length of the stroke, for the shell, may be double that for the powder bags. Having loaded the gun the next step is to screw in the breech block, which in some cases is also done by a small motor.

During all these operations the men in charge of sighting the guns are busy. The electric range-finder has given the distance and the turret has been turned to the proper angle. The latter operation is an exceedingly delicate one, and a great many systems have been proposed for getting the necessary results. The first used on the older ships was a voltage control system, a separate generator or motor-generator set being employed for each turret. In its simplest form a single motor drove the turret throughout its entire range of speed, and was controlled by varying the field of its generator. The regulation was not entirely satisfactory, however, and this was superseded by what is known as the rotary compensator system. In this, two armatures having independent fields are

*From the *General Electric Review.*

mounted on one shaft and connected in series; and two motors, one of much larger capacity than the other, are connected across the terminals of the armatures of the rotary compensator. The speed of each motor is then regulated by varying the field of its counterpart in the compensator. These fields are connected in series across the feeders, their common middle connection being attached to the arm of a field rheostat, the resistance of which is also across the feeders.

With this arrangement, and the use of electric clutches for the small motor, the full speed range of both motors can be made use of; and it has the great advantage over the use of a single motor, in that the slow speeds are far more stable and are accompanied by better torque. Nevertheless it does not give quite ideal results, as it has been found impossible to obtain with it a straight line speed curve; for the reason that the speed changes of the large motor are too small at some points and too large at others. Another system in use consists of two motors driving a differential gear, the speed of the turret being obtained by varying the field strength of the two motors. This system has given good results; but the difficulty of electric control, due to the self-induction of the field magnets and the inertia of the armatures, has led to the preference for hydraulic speed gears, driven by constant speed motors.

The elevation of the guns is a simpler matter and is accomplished by a motor and hydraulic speed gear. The relative capacities of motors used in the turret are of interest and are shown in the following table for the U. S. S. *Florida*:

	H. P.
Upper ammunition hoist	60
Lower ammunition hoist	25
Rammer motor	7
Elevating motor	15
Breech-block motor	3.5
Turret-turning motors for hydraulic gear	25

Boat Crane Controllers

Boat crane controllers, since they must of necessity be exposed to the weather, are made water-tight. Each contains as a rule two cylinders, one for hoisting and one for swinging the boat over the side. They also contain magnetic blow-out circuit-breakers, which can be set by handles extending through the covers and tripped by push-rods passing through stuffing glands. The hoisting cylinders usually operate by rheostatic control, the load being held by a spring-operated magnetic disk brake when the controller is at the "off" position, or in case of failure of voltage; and an excessive speed in lowering is prevented by an automatic mechanical brake. In the latest types the lowering control is electrical rather than mechanical, and makes use of a principle similar to that in ammunition hoists. The cylinder for the rotating motor is generally arranged like the older ammunition hoists. Hoisting motors for boat cranes are usually of 50 horsepower capacity; while the rotating motors are usually about 30 horsepower to 40 horsepower.

Forced Draft Blowers

The control of forced draft blowers would require no consideration here if only one blower were used for each boiler room, and the space for the motor and equipment were less limited than they are on shipboard. These two conditions, however, add certain elements of risk which must be taken care of by special means.

It is characteristic of two properly-designed blowers, of like capacity, acting together, that they will divide the load equally; but that if either stops, the load on the other will at once increase. We must also remember that the blower motor speeds must be varied according to steaming conditions, and to do this economically the field strength of the motors are varied. If now, while two blowers are running at full speed, one of them is stopped, the other immediately becomes overloaded; but its load can be reduced by simply strengthening the field of its motor. This is done by the use of an overload relay which short-circuits the field resistance. Controllers for forced draft blowers sometimes have a further complication on account of the necessity of operating them from more than one point. Under these circumstances, if it is also required that the special handle and contact, spoken of above, be employed, the circuits become quite complicated.

Steering Gear Control

Electric control of steering gear has been studied almost from the beginning of the use of electricity on shipboard, but the necessity for absolute reliability combined with extremely severe service has, until recently, prevented its use except in a few experimental installations. The improvement in the reliability of control apparatus has of late, however, brought this matter into prominence, and several recent ships are now being equipped with electric steering gears. In general, most systems include some form of follow-up device; i. e., a device so designed that as the rudder turns it will cut power off the motor which turns it. This feature in an analogous form has been almost universally applied to steam gears; and since the latter also will be installed as alternative means of steering on the ships which are to have electric gear, it is natural to insist that the same method shall be employed for control by either system. This can be accomplished by a wire rope transmission or by means of a device known as a telemotor. This consists of two cylinders containing pistons, and connected together by piping on both sides of the pistons. If one piston is moved the other will be forced to move also, and can be used to operate either a steam valve or a master controller. This arrangement eliminates all wiring between the steering stand and the electrical apparatus.

In other systems a pilot motor control is used between the steering-stand and the main controller; while in others a Wheatstone bridge arrangement is employed for controlling the exciter of the special generator which furnishes power to the rudder motor. In still others no follow-up device is used, depending on an indicator to show the position of the rudder. Aside from these features of remote control it is interesting to consider the mechanical characteristics of this problem. We must appreciate in the first place, that, to maintain even an approximately straight course, the rudder must be shifted constantly, seldom remaining in a fixed position for more than a few seconds. This necessitates constantly reversing the operating motor, which means the severest kind of service for the controlling apparatus. Another difficulty is the extremely variable load, which may change from a very small value to 100 percent overload an instant later. Fortunately the reversal of torque can be controlled to some extent by operating the rudder through the agency of a large screw having right and left threads at opposite ends, these threads carrying nuts to which links are attached which act on a cross-head on the rudder. The pitch of the threads is small enough to prevent the rudder from driving the screw, and consequently there will be but a very slight tendency to drive the motor even with the screw turning rapidly. Even with this arrangement a shunt around the motor armature can be employed to good advantage in order to stop the rudder quickly, when the pressure of the water and the momentum of the motor are tending to drive it.

Steering gears for large ships require as high as 300 horsepower for short periods; and since 120 volts is used on all American ships the current is very large and requires the use of magnetic switches. In the Argentine Navy 220 volts has been adopted, which has considerably lightened the equipments on the two ships now being furnished with electric gear.

Tug and Passenger Tender Flying Kestrel

Description of an Interesting Vessel Fitted for Passenger Service on the Mersey or for Deep Sea Towing and Salvage Work

Fig. 1 shows an interesting type of steel screw tug and passenger tender, the *Flying Kestrel,* which was built by Messrs. J. T. Eltringham & Company, of the Stone Quay, South Shields, to the order of the Alexandra Towing Company, Ltd., of Liverpool. While embodying the latest improvements in design and fittings for the conveyance of passengers to and from the large liners frequenting the Mersey, this vessel will also be capable of undertaking long voyages in connection with towage or salvage work.

The *Flying Kestrel* has an over-all length of 153 feet, and its beam is such as to ensure stability when carrying a full complement of passengers on the promenade deck. The propelling machinery consists of powerful triple-expansion engines, supplied and fitted by Mr. George T. Grey, of South Shields, steam being supplied by two large multi-tubular boilers, built by Messrs. Eltringham, and working at a pressure of 180 pounds per square inch.

Fig. 1.—Passenger Tender and Tug *Flying Kestrel* for Atlantic Liners at Liverpool

The general arrangement of the vessel has been evolved from the long experience of the builders and owners in several somewhat similar but smaller craft. There are five decks—the lower, main, promenade, bridge and flying deck, the last-mentioned being on top of the chart house, and having a steering wheel and standard Morse signal lamp, two engine-room telegraphs of the repeating type, and a Kelvin & White standard compass fitted.

Below this is the bridge deck, with chart house, containing the electric light switches for the navigation lights and cargo clusters, and an inter-communication telephone system connected with all parts of the ship. On the deck are stowed two of the four boats provided for life-saving, and there are also large teak life-belt boxes placed alongside the coaling hatch. Forward of the charthouse the deck is fitted with teak doubling, and there are sliding gangway openings in the rails for landing passengers from the large liners.

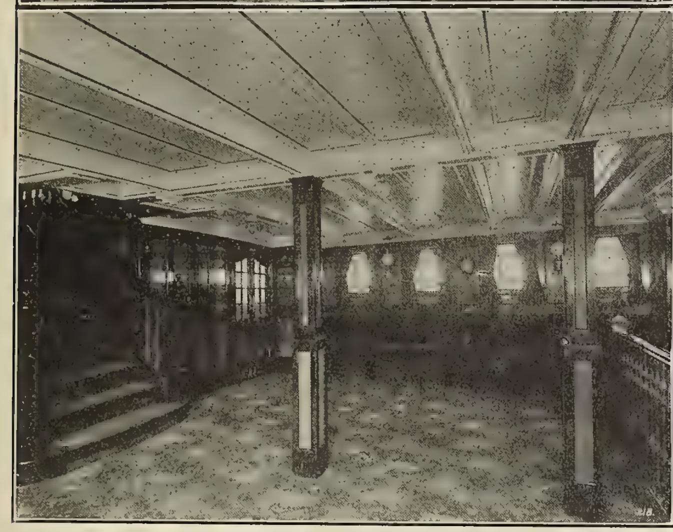
By two wide stairways leading down at an angle of 40 degrees access is gained to the promenade deck below, this being the principal passenger deck, and constructed so as to be measured by the Board of Trade for passengers the full width of the ship. On this deck, right aft, is the hand-screw steering gear and standard compass, to be used in case of failure of the steam steering gear, and forward of this on either side is a large hatch with removable teak top through which passengers' luggage is lowered to the main deck. Forward of the aftermost tow-rail is fitted a large teak grating for the stowage of the towing ropes, which are handled by a very powerful steam capstan fitted with a barrel of extra large diameter, this capstan being used also for warping purposes when required. Forward of this, again, is a very large teak companion with double-slipping top covering the stairway to the after main deck, and alongside are carried two other lifeboats slung in davits and lashed against a pole with special leather-covered pads to prevent damage to the boats. Further forward, on each side, are two specially designed openings in the rails with teak doubling on the deck for landing passengers, two gangways fitted with rollers and india rubber treads being provided for this purpose.

On this deck there are three very strong tow rails, with portable side pieces fitting into strong sockets on the rails, the latter being made of great strength and connected all around by a heavy angle bar surmounted with a teak rail. The towing gear, consisting of two strong slip hooks working on a semi-circular tow-bar, is connected to the aft end of the deck casings, and when not in use the gear is covered by a semi-circular teak seat constructed so as to be easily removable.

The deck casings on this deck contain two staterooms tastefully fitted out in polished oak, each having a folding bed, also sofa with drawers under, cabinet folding wash basin, and steam heater, while at the forward end is a large deck house entrance to the main saloon, with a wide oak staircase, the steps of which are fitted with fluted india rubber treads and brass nosings.

At the extreme fore end of the promenade deck there are two large warping capstans and cable lifters for handling the heavy stockless anchors, the machinery for working which is situated on the main deck below, and access to the engine is gained from a steel companion. This machinery is so arranged that it can be worked either from the promenade deck or the main deck.

From the deck house, previously mentioned, the stairway leads to the main saloon, this being handsomely fitted in two



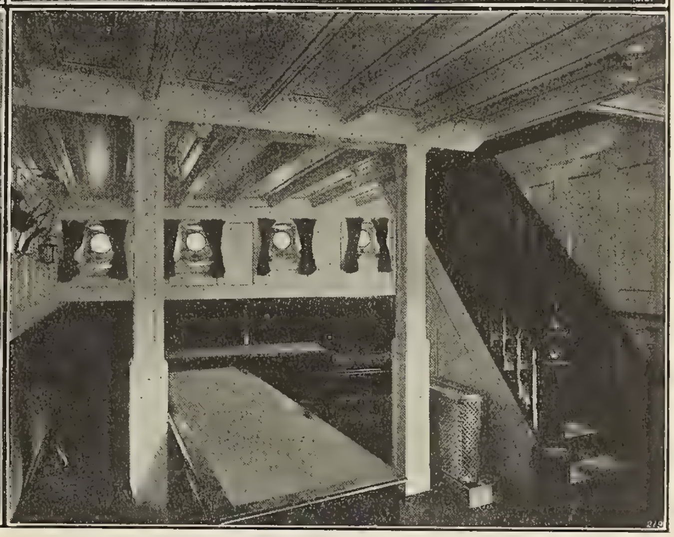


Fig. 2.—Part of Ladies' Saloon
Fig. 4.—Main Deck Saloon

Fig. 3.—Main Deck, Looking Forward
Fig. 5.—Dining Saloon

shades of polished oak, an Axminster carpet fitted on thick felt being laid on the deck. The upholstery is of dark blue velvet, and in conjunction with the side-light curtains of old gold damask and electro-plated fittings, gives to the whole a very handsome appearance. The system of steam heating and electric fan ventilation ensures comfort in all states of the weather.

From this saloon tastefully designed swing doors with beveled glass panels lead on the port side to the smoking saloon, and on the starboard side to the ladies' saloon, these being fitted in a style corresponding to the main saloon. At the fore end of the main saloon a staircase leads to the under deck saloon, which is fitted with folding beds, so arranged that they are housed behind the seat backs when not in use. This saloon may also be used as a dining saloon, four large tables being fitted for this purpose, and there is also a heating and ventilation system of the same kind as in the saloon above.

After passing from the deck saloon access is gained to the main deck through the smoking saloon, there being side houses fitted containing lavatories for passengers and crew, also the various storerooms, pantries, etc. In the main deck casings are contained the galley, entrance to engine room, crew space, officers' quarters and large cupboards containing the life-belts for the use of passengers in case of emergency, while right aft there is a steel bulkhead across the full width of the ship, forming a separate compartment for the steam steering engine, in addition to a large storeroom and lamp-room.

At each side of the main deck aft there is fitted a specially designed double steel door, made to hinge outwards, and used in connection with the hatch above on the promenade deck for the purpose of taking on board passengers' luggage, which is thus very quickly placed in a position secure from bad weather.

At the official trials a speed of over 12 knots was attained, and the maneuvering qualities of the vessel were demonstrated in a very satisfactory manner.

The Rolling of Ships

BY ARTHUR R. LIDDELL

The rolling of a vessel is brought about by a succession of impulses given by the waves at regular intervals of time much in the manner of those applied to a garden swing. The resistances of the parts of her outer surface above and below the loadline are much the same in degree, and provided the impulses be given at intervals of time which synchronise with her period, the oscillations will steadily increase in amplitude until some disturbing influence other than that of the surface friction of the outside plating intervenes. The fitting of bilge rolling keels increases the proportion borne by the total resistance to the force of the periodic impulse, and thus lengthens the time during which the vessel rolls up to a given angle of heel, but it does not alter her period of rolling to any considerable extent. Only the amplitude of the individual oscillations is reduced by it. An additional resistance, which

acts intermittently, comes into play after the deck has become immersed. A wedge of water is then raised and thrown off at each side or across the deck, the effect of which in retarding the motion is intermittent, and thus differs from that of the constantly immersed bilge keel. The rolling motion is thereby checked, and the synchronism is disturbed more and more as the immersion of the deck increases, until the divergence of the periods of ship and waves becomes considerable. The ship then gradually becomes steady, and remains so till successive wave impulses set her going again in oscillations of increasing amplitude as before.

The check thus afforded by the sides of the deck might equally well be applied by projecting fins fitted on the vessel's sides above the water, perhaps towards the ends so as not to project beyond the extreme breadth. It may here be noted that side fenders fitted on some of the vessels plying in the Irish Sea were currently asserted to damp their rolling motions. In regard to bilge keels in the ordinary positions, there are various contrivances, such as those of cutting holes through them, fitting them with hinged flaps, etc., which might be tried with a view to the increase of their effect. It would be well if the experimenting institutions could find time to invent and make trial of devices of this nature on their own account.

Now an ocean wave of a given length has a period equal to 2.263 $\sqrt{\text{length in feet}}$; but the period of a vessel is not so readily obtained; its determination by calculation has hitherto been looked on as a very long and laborious process, and it has indeed rarely been attempted. The formula given by Sir William White for the period of a vessel is

$$T = .554 \sqrt{\frac{k^2}{m}},$$

where T is the still-water period in seconds for a single roll; m = the metacentric height ($G\ M$) in feet, and k = the radius of gyration of the vessel and her cargo in feet.

The factor which varies most in the foregoing is the root of the metacentric height, but this may be calculated, found by direct experiment, or assumed; the radius of gyration, or $\sqrt{k^2}$, has hitherto been the difficulty. The question which arises most often in practice is: with what degree of stability, as expressed in metacentric height, does a given ascertained period correspond? and before this can be answered the radius of gyration must somehow be found. Now, although an exact calculation of this radius may be a considerable undertaking, an approximate value for it, which will generally answer the desired purpose, can be more readily obtained. A loaded vessel consists in the main of a hollow steel cylinder or shell filled with more or less homogeneous cargo and inner structural parts, such as bulkheads, lower decks, etc. The radius of gyration of the shell, *i. e.*, of the outer platings and framings, will in full-formed cargo vessels approximately coincide with that of the periphery of an equivalent rectangle that is slightly narrower and perhaps shallower than the midship section of the vessel. The radius of gyration of the cargo and inner structural parts may be taken to coincide with that of an equivalent circle, ellipse, triangle or other geometrical figure the properties of which are known. The figure to be chosen for comparison in the latter case may be determined by an inspection of the midship section. It may be objected that these are mere approximations, but, as will be seen in the following, the percentages by which they are likely to differ from the realities are not so great as very materially to affect the metacentric heights that must, in vessels of given periods, accompany them. It will also appear that the error in any particular case may be reduced by the application of a combined system of calculation and observation.

The weight of the shell, including the outside plating and upper deck, and the parts of the general framing, etc., which are in immediate proximity to these, may in many cases amount to about 20 percent of the displacement; in some passenger ships and yachts it may, of course, be considerably more. The weights of the parts in question will in most cases be already known to the designer, and in similar ships they will form a fairly constant proportion of the whole weight of the hull. The remainder of the weight of the ship added to that of the cargo may then be taken to be evenly spread over the surface of the transverse geometrical figure chosen. To simplify the work, the squares of the radii of gyration of the hollow rectangles and of the surfaces of geometrical figures given in the table have been calculated:

TABLE I.—RECTANGLE ABOUT CENTER OF GRAVITY.

Proportion of Depth to Breadth.	(Radius of Gyration)^2 in Terms of Half-Breadth of Vessel Taken as Unity.	
	Shell.	Surface of Transverse Plane.
.8	1.093	2.186
.7	.993	1.986
.6	.907	1.814
.5	.833	1.666
.4	.773	1.546
.3	.726	1.452

TABLE II.—TRIANGLE ABOUT CENTER OF GRAVITY.

Proportion of Height to Breadth of Base.	(Radius of Gyration)^2 in Terms of Half-Length of Base as Unity.
.8	.309
.7	.276
.6	.247
.5	.222
.4	.202
.3	.187

TABLE III.—CIRCLE OR ELLIPSE ABOUT CENTER OF GRAVITY.

Proportion of Minor Axis to Major Axis.	(Radius of Gyration)^2 in Terms of Half-Length of Major Axis as Unity.
1.0	.500
.9	.452
.8	.410
.7	.372
.6	.340
.5	.312
.4	.290
.3	.272

The tabular figure must in each case be multiplied by the square of the proportion borne by the half-breadth of the vessel to the radius of circle or half-length of base, respectively. As an example of the application of the table we may take a vessel of depth to breadth = .75, with short erections and deckhouses, the equivalent transverse plane for which may be nearly equivalent to that of a circle with center at a height above the base of the squared midship section equal to half the breadth. The tabular figures are:

For the hollow rectangular 1, and for the transverse figure .5.

If the weight of the shell be taken at .2 of the whole we have

For the hollow rectangle.......... $1 \times .2 = .2$
For the transverse figure.......... $.5 \times .8 = .4$

For half-breadth = 1 (radius of gyration)^2 = .6

If the half-breadth of the vessel be 20 feet the square of the radius of gyration $= 20^2 \times .6 = 240$.

Assuming a $G\ M$ height = 1 foot, the period of the vessel will be equal to

$$.554 \times \sqrt{\frac{240}{1}} = 8.57 \text{ seconds.}$$

If the period be known and not the $G\ M$ height, the calculation for the latter will be

$$\frac{T^2}{k^2 \times (.554)^2} = \frac{(8.57)^2}{240 \times (.554)^2} = 1 \text{ foot.}$$

The question now arises: What difference the maximum probable error in the square of the radius of gyration can make in the final result? The radius of gyration of the shell cannot be greatly varied, but the approximate value for the radius of gyration of the remaining weights might perhaps be wrong by 5 percent, which would give an error of about 10 percent for the $(\text{radius})^2$; the $(\text{radius})^2$ for the whole weight in the above calculation would then vary between .56 and .64, or by about 7 percent from the mean value .6, and the $G\ M$ height in the same proportion, *i. e.,* by less than 1 inch. The difference of the period, which varies with the simple radius of gyration, would then be about three seconds.

Assuming the perhaps improbable error of 10 percent instead of 5 percent for the radius of the cargo and inner structure, the $G\ M$ height would be wrong by less than 2 inches and the period by about six seconds.

In applying the "equivalent figures" in Table II., the naval architect should take care to compare the values of their radii of gyration with the corresponding ones obtained from actual vessels, wherever such are available, and thus check his estimates, in particular of the radii of gyration for different conditions as regards machinery, fuel, cargo and ballast, and should, if necessary, introduce coefficients applying specially to his own designs.

The uses of the period obtained for a vessel are twofold. In the first place, it gives indication of the length of wave and force of wind at which synchronous rolling may be expected to occur, and in the second it may be an instrument in the hand of the captain for easily ascertaining by experiment at the beginning of a voyage whether his vessel is so loaded as to have a suitable degree of stability. The experiment is the one, probably familiar to him, of making his vessel roll by setting men to run to and fro across her deck. If the men run, say, first to starboard, the vessel will make an inclination in the same direction. As soon as she lifts to roll back the men must run over to port. There they must await the lift again to run back to starboard. An amplitude of rolling large enough to be measured may be obtained by a few well-timed runs made by comparatively few men. The number of seconds in which she makes, say, ten rolls may then be noted and divided by ten for the period of a single roll. This experiment is of importance to the captain as a measure of the stability of his vessel when loaded with a cargo similar to one that he has carried before. He may indeed be informed on taking over his vessel that a certain period should not be exceeded, but in the course of a voyage or two his own observation will teach him what the period indicates. If he has sailed with a much shorter period than the one given, he will know that his ship was undesirably stiff; if he has had a very long period he will know that she was tender. In some cases he may be able to correct the calculated period and substitute a more suitable one obtained by observation; in any case he has a new "foot-rule" by which to measure initial stability for himself.

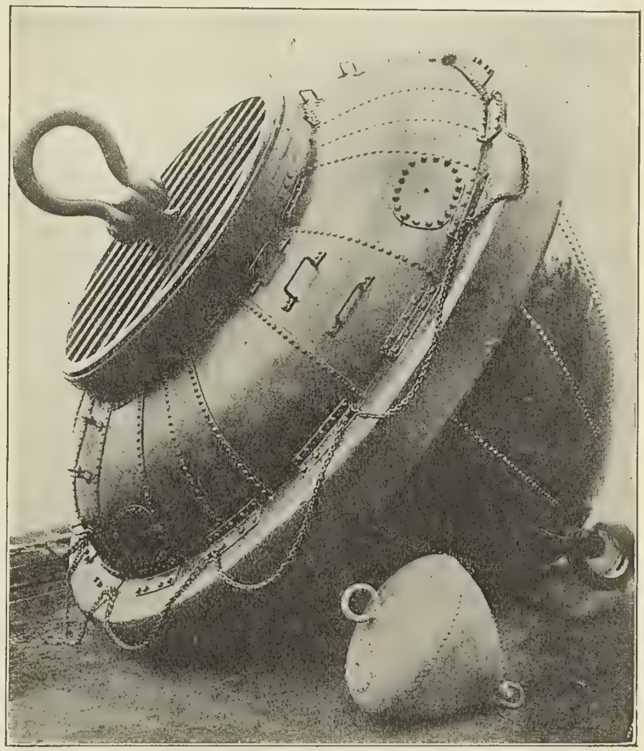
The period of a vessel with principal dimensions of $1{,}000 \times 100 \times 70$ feet, a $G\ M$ height of 1 foot and a $(\text{radius of gyration})^2$ of 1,500, might be about 22 seconds; if the $G\ M$ height were only 9 inches the period would be 25 seconds. Now the critical wave, the half period of which would be 22 seconds, has a length of 9,920 feet, and that for a half period of 25 seconds 12,800 feet, and such waves would seldom or never be encountered.

One of the lessons to be learned from the foregoing is that ships of the very large dimensions and small metacentric height now given, or contemplated, cannot roll to any considerable extent, and indeed have outgrown one of the most keenly-felt disagreeable features of the sea.

Mooring Buoy for Brazilian Super-Dreadnought

BY FRANK C. PERKINS

In order to carry the exceptionally heavy moorings for the Brazilian super-dreadnought *Minas Geraes,* which is one of the largest and most heavily armored war vessels afloat, the Brazilian Naval Commission had constructed recently at the works of Brown, Lenox & Company, London, Ltd., at Millwall, a 15-ton buoy built of ⅜-inch mild steel plates. The buoy itself is 15 feet in diameter, and is divided into four watertight compartments. Through the center passes a forged iron mooring bar designed to withstand a breaking-off strain of 185 tons. This has a fixed shackle, made from 6-inch diameter iron at the top and a 5¾-inch diameter swivel at the bottom. There is attached to the crown plate a wooden platform, 8 feet 6 inches diameter, to enable the men to stand with safety while making fast or letting go the ship's cable. At the line of flotation the buoy is provided with an elm fender, 15 inches thick and 18 inches deep, to take the impact in the event of collision. With the mooring bar, the buoy weighs 15 tons, and is capable of carrying besides its own weight a load of 7½ tons when one of the watertight compartments is filled with water.



Buoy for Mooring a Super-Dreadnought

Launch of the Frank H. Buck.—The oil tank steamer, *Frank H. Buck,* building at the Union Iron Works, San Francisco, for the Associated Oil Company, was launched March 11. She is the first longitudinally-framed vessel built on the Pacific coast.

McAndrew's Floating School

BY CAPT. C. A. McALLISTER*

"Why can't we get some of the old examination papers?" observed Nelson.

"Just try it for yourself and see," said McAndrew. "In the first place they are not published, so it is not necessary to give any other reasons.

"I have, however, put down in my notebook a number of the questions that were asked me on my different examinations, and I will give you the benefit of some of those I have had, and also of some of those I have obtained from other engineers. They are as follows:

Questions and Answers from Marine Engineers' Examination Papers

Q. What is the advantage of a triple-expansion engine over a compound; how is the power divided; how can you tell when the power is equally divided?

A. Greater economy, due to a greater degree of expansion of the steam; the power should be divided as nearly equally as possible between the three cylinders; the only way to ascertain whether the division is equal or not is to take a set of cards from each cylinder and calculate the horsepower which each develops.

Q. What are the principal types of condensers?

A. Jet and surface.

Q. What are the necessary appliances for operating a surface condenser?

A. The circulating pumps for forcing the cooling water through the tubes, and the air pump for pumping out the condensed water and the vapor from the interior of the condenser.

Q. How would you ascertain if a condenser was leaking salt water?

A. By taking off the water chest at each end and filling the condenser with fresh water. If any water runs out through the ends of the tubes there are leaks in the tubes, which, when the condenser is in operation, would admit salt water to the condenser.

Q. How many sets of valves are there in an air pump; which set could be dispensed with and the pump continue to work?

A. The valves are known as foot valves, bucket valves and discharge valves. The pump could run without foot valves, but it works better with them.

Q. What is a vacuum?

A. A vacuum means absence of air.

Q. What is steam?

A. Steam is a thin, invisible, elastic vapor formed by the application of heat to water.

Q. Is it possible to get a perfect vacuum?

A. It is not.

Q. If a vacuum gage shows 24 inches, how many pounds pressure does that indicate?

A. About 12 pounds.

Q. Suppose the steam gage shows 60 pounds and the vacuum gage 24 inches, what would be the pressure in pounds per square inch on the piston?

A. One-half of 24 inches means a pressure of 12 pounds, so the pressure per square inch on the piston would be $60 + 12 = 72$ pounds.

Q. What is the duty of a condenser?

A. A condenser serves the purpose of condensing or turning the exhaust steam back into its original state as water; in this operation a vacuum is formed which increases the power of the engine by carrying out the expansion of the steam to nearly its limit.

Q. How does a leaky condenser affect a boiler?

A. It allows salt water to be fed to the boiler, and if the leak is extensive it will cause too great a quantity of water to accumulate in the boiler, so that the boiler will have to be blown down at intervals.

Q. Describe the course of steam from the boiler to a triple-expansion engine, naming the valves and pipes, etc., it passes through until in the form of water it reaches the feed tank?

A. The steam after being formed in the boiler first passes through the dry-pipe, the object of which is to keep the water out of the steam. It then passes through the main stop valve on the boiler into the main steam pipe. In the main steam pipe is sometimes fitted a separator which removes the water from the steam. Passing through the throttle valve it enters the high-pressure steam chest, thence through the high-pressure valve into the high-pressure cylinder; after a certain degree of expansion in that cylinder it is exhausted into the first receiver, and passing through the intermediate valve it enters the intermediate cylinder, where another degree of expansion ensues. It is exhausted from the intermediate cylinder into the second receiver, and thence through the low-pressure valve into the low-pressure cylinder, where it is expanded to its final stage and then is exhausted into the condenser. There it is transformed into water by coming in contact with the surface of the cold tubes. This water is pumped out of the bottom of the condenser by means of the air pump, and is discharged into the feed tank, whence it is again pumped into the boilers by means of the feed pump.

Q. Where should the throw of the eccentric be placed in relation to the crank of a slide valve engine?

A. It should be set ahead of the crank where the steam is taken on the outside of the valve.

Q. How would you set an eccentric on a new shaft to have the valve properly set?

A. Ninety degrees ahead of the crank, plus the amount of the lap, plus the amount of the lead. Before setting the eccentric you should lock it with a set screw, and then by turning the engine around one revolution see that the lead is correct for both ends. After it is found to be in the correct position then mark and cut the keyway in the shaft.

Q. What is meant by lap?

A. The amount a slide valve overlaps the steam port, when it is in mid-position, if it is on the steam side. On the exhaust side it is the amount it overlaps the exhaust side. The former is used for regulating the cut-off and the latter to provide compression at each end of the stroke.

Q. What is meant by lead?

A. By lead is meant the amount the valve is open when the piston is at the end of its stroke. Lead is given to admit steam before the piston reaches the end of the stroke, and to start it off promptly on the new stroke.

Q. Can steam be cut off equally in the two ends of a cylinder when using a lap valve?

A. No, it cannot, for the reason that the crank is not horizontal when the piston is at half stroke, but a little above the center, due to the angularity of the connecting rod. When the crank is horizontal the piston is a little below the center of its stroke, therefore the steam follows further on the top.

* Engineer-in-Chief, United States Revenue Cutter Service.

Q. Is the lead increased or decreased by shifting the link to mid-position?

A. If you have "open" rods the lead will increase as we run in the links, and we shorten the point of cut-off. If the rods are crossed the opposite is the case.

Q. What are the practical limits of cutting off with a slide valve?

A. It is not practicable to cut off very short with a lap valve, on account of the excessive lap necessary and the increased travel of the valve. Generally speaking, it is inadvisable to cut off at less than ⅝ the stroke, nor more than ⅞.

Q. What is the difference in the throw of an eccentric of a double-ported valve from that necessary for a single-ported valve?

A. Double-ported valves are used to reduce the travel of a valve by giving a double admission at each end, hence the travel is only one-half that of a single-ported valve.

Q. Find the area of opening in a boiler shell for a duplex safety valve, each valve being 3½ inches diameter.

A. $3.5 \times 3.5 = 12.25$, this multiplied by $.7854 = 9.62$ as the area of one valve; $9.62 \times 2 = 19.24$ as the area of the hole in the boiler. The diameter corresponding to that area is practically 5 inches.

Q. What is meant by foaming or priming? How do you explain the cause?

A. "Foaming" is the violent boiling or ebullition of the water in the boiler, the water level rises and falls rapidly, and water gets mixed with the steam and is carried to the engine; this latter action is known as "priming." Foaming is liable to occur when the boiler is dirty; when the boiler is forced to a great extent; when changing from salt to fresh feed; when too much soda is used in the boiler, or if the boiler does not have sufficient steam space.

Q. How would you check "foaming"?

A. Slow down the engine; put on a strong feed; pump and blow if necessary.

Q. What precautions are necessary when the boiler is priming?

A. Open all cylinder and valve chest drains, and if necessary slow down the engine.

Q. What are the bad effects of oil or grease getting into the boilers?

A. The oil forms a scum on the surface of the water in the boiler, and gradually collects together with particles of salt scales, sulphate of lime, etc., and will finally settle on the tubes or on the furnace crowns. Being a very poor conductor of heat it is liable to cause the metal to become overheated, with consequent collapse or bulging of the furnaces. The oil will also become decomposed, form acids and expedite electrolytic action, with its consequent pitting of the steel plates and tubes.

Q. What density would you carry the water in the boiler, using a high-pressure of steam, such as 180 pounds?

A. With steam at that pressure allow the density to rise as high as 4 or 4½ thirty-seconds before blowing, as with high temperature if we keep blowing to hold the density low, we increase the scale as the calcium sulphate in the sea water deposits at the comparatively low temperature of 290 degrees F.

Q. How would you determine the density of boiler water if the salinometer was out of order?

A. By means of noting the boiling point. Fresh water boils at 212 degrees F. under atmospheric pressure only. Ordinary sea water boils at 213.2 degrees F. At a density of 2 thirty-seconds it boils at 214.2 degrees F., and so on.

Q. How high should the water be carried over the tops of combustion chambers?

A. Not less than 6 inches.

Q. Describe a fusible plug. Where are they placed in a boiler? and for what purpose? What materials are used in their construction?

A. A fusible plug is usually made of brass, filled with Banca tin. They are to relieve the pressure in case of low water in the boiler, the theory being that the tin will melt out when there is no water over it, and allow the steam to blow through the hole thus formed. In boilers having combustion chambers they must be placed in the top, or the highest heating surface. In flue boilers one must be placed in each flue and one in the shell of the boiler from the inside just below the fire line, and not less than 4 feet from the forward end of the boiler.

Q. Where would you use a soft patch on a boiler, and how should it be applied?

A. A soft patch should be used over a weak spot on the boiler, or over a part of a joint where the rivets are corroded away and leaking. It should never be used where it will come in contact with the fire or flames. It is usual to make them of 3/16-inch or ¼-inch plate, and of a size sufficient to overlap all portions of the weak spot to be patched. A templet of lead should be made for the patch. The patch itself should be made to correspond to the templet; it should be lipped around its edges, so as to hold the putty of red lead and iron filings. Each bolt should be fitted with washers and grommets of asbestos thread rubbed down with white lead. Bake the patch with heated irons and set up as tightly on the bolts as possible.

Q. Where on a boiler would you use a hard patch, and how should it be applied?

A. A hard patch is used for a permanent job, and can be fitted over a hole or defective part of the boiler, even if it does come in contact with the fire. The defective part should be cut out, a templet made large enough to allow for a riveted joint all around the hole. The holes should be drilled from the templet, and when all is ready drive the rivets and calk the edges all around the same as in regular boiler construction.

Q. Upon what does the strength of a cylindrical boiler depend?

A. Upon the thicknes of the shell.

Q. Why are two safety valves used instead of one?

A. The combined area of the two valves must be equal to the area of one valve, as required by the rules of the Steamboat Inspection Service. When two valves are used there is less likelihood of both getting out of order than would be the case if only one is used.

Q. What should be the angle of the seat of safety valves?

A. The seats should have an angle of inclination of 45 degrees to the center line of their axes.

Q. What determines the size of safety valves of different kinds?

A. Lever safety valves must have an area of not less than 1 square inch to 2 square feet of the grate surface. Spring loaded safety valves must have an area of not less than 1 square inch for each 3 square feet of grate surface, except for watertube boilers carrying a steam pressure exceeding 175 pounds per square inch, when they are required to have an area of not less than 1 square inch for each 6 square feet of grate surface.

Q. Name all the valves on a boiler, stating the most important one and where it is placed.

A. The valves on a marine boiler are the safety valve, main stop valve, auxiliary stop valve, main feed check valve, auxiliary feed check valve, surface blow valve, bottom blow valve, drain valve and sometimes a sentinel valve.

The most important one is the safety valve, which is placed on the shell at the highest part of the boiler.

Q. What would be the result if both feed valves were shut on a boiler and the engine was in motion at full speed?

A. The water in the boiler would be gradually used up, and if not replenished the boiler would explode.

Q. Does the water in the glass always show the true level in the boiler?

A. No, it does not. Occasionally the pipes leading to the gage glass may become choked up with hardened oil, or the valves may not be opened. These should be frequently tried to see that they are kept open.

Q. A ship has six double-ended boilers with six furnaces, each of which is 6 feet 6 inches long by 3 feet 3 inches in diameter, and when the ship is making 15 knots there is 15 pounds of coal burned per square foot of grate area per hour. How many tons of coal would be required for a voyage of 3,000 miles, and how many tons would be burned each day?

A. As each furnace is 6½ feet long and 3¼ feet in diameter, there would be 6½ × 3¼ = 21⅛ square feet in each furnace; 21⅛ × 6 = 126¾ square feet of grate surface in each boiler; 126¾ × 6 = 760½ square feet of grate surface in all the boilers; 760½ × 15 = 11,407½ pounds, or 5.09 tons of coal burned per hour; 3,000 ÷ 15 = 200 hours' time to make the voyage of 3,000 miles; 5.09 × 200 = 1,018 tons to make the voyage of 3,000 miles; 5.09 × 24 = 122.16 tons burned each day.

Q. If you were in charge of a modern triple-expansion engine, and the intermediate connecting rod broke beyond repair, what would you do?

A. Disconnect the rod at both ends; take out the intermediate valve, so as to allow the steam to pass from the high-pressure exhaust direct to the low-pressure valve chest and proceed on the voyage, using only the high and low-pressure cylinders.

Q. How long would you run a boiler if you had used only fresh water as feed before cleaning it?

A. About 700 steaming hours with the main engine in use would be about the safe limit before opening the boiler to clean it, as it will be found at the end of that time that the zincs will need renewing.

Q. If the high-pressure valve stem broke beyond repair what would you do?

A. Take out the high-pressure valve and let the live steam from the boilers blow directly through to the intermediate valve chest, and run the engine compound with the intermediate and low-pressure cylinders.

Q. How many gallons of water is pumped per hour by a single-acting plunger pump, whose diameter is 6 inches, stroke 10 inches, and making 60 strokes per minute?

A. The area corresponding to a diameter of 6 inches is 28.27 square inches. This is found by multiplying 6 × 6 = 36 × .7854 = 28.27 square inches. Now 28.27 × 10 inches = 282.7 cubic inches per stroke; 282.7 × 60 = 16,962 cubic inches per hour; 16,962 ÷ 231 (number of cubic inches per gallon) = 73.4 gallons per minute; 73.4 × 60 = 4,404 gallons per hour.

Q. What are the principal things to look after upon taking charge of a watch?

A. See first if there is a half a glass of water in each boiler, that the fires are clean, that the ashes have been blown out, that some coal is out on the plates, that no bearings are running warm, that the feed pump is working well, and that a good vacuum is being carried.

Q. What height must a safety valve be raised or lifted to allow a free escape of steam equal to the area of the valve?

A. One-fourth the diameter; thus with a 4-inch safety valve it should be lifted 1 inch.

Q. Why are counterbores put into each end of a cylinder?

A. To allow the piston to run over the edge at each end of the stroke, so that it will not wear shoulders in the bore of the cylinder.

Q. A cylinder is 30 inches diameter, the steam pressure is 125 pounds, and 30 bolts hold the cylinder cover in place. What is the stress on each bolt?

A. The area corresponding to 30 inches diameter is 30 × 30 × .7854 = 706.86 square inches, 706.86 × 125 = 88,357.5 pounds total stress on the cylinder cover; 88,357.5 ÷ 30 = 2,945.25 pounds stress on each bolt.

Q. How should the valves be connected to a boiler?

A. They should always be bolted to the shell, never riveted or screwed.

Q. How would you find out the distance the piston and shaft had worked down?

A. It is customary to mark on the cross-head slipper and cross-head guides the position of the piston at the top of the stroke. If it has worked down from the original position the amount will be the difference between the marks on the guide and the slipper. A tram is usually furnished with every engine showing the position of the top of the crankshaft, relative to the facing on the top of the bed-plate under the bearing caps. If the shaft is worn down, the distance can be ascertained by fitting the tram in place on the bed-plate facing and measuring the space between the tram and the top of the crankshaft.

Q. What are the principal things to look after before starting fires?

A. See that there is sufficient water in the boiler, that all valves work freely, particularly the feed check valves; that the air cock or the top gage cock is left open, to allow the air to escape, and that all man and hand-holes are set up tightly.

Q. Before turning the engine over what precautions are necessary for the engine and vessel?

A. Inform the deck officers so that they can see that sufficient lines are out to hold the vessel to the wharf, and that everything is clear around the propellers. In the engine-room see that the turning gear is disconnected; that the water service is turned on; that all bearings have been oiled; that there is nothing in the crank-pits, and that all hands are clear of the engine.

Q. When the pumps are connected to the engine what would you look after before starting?

A. See that the air pump is not filled with water, and that all valves on the discharge side of the feed pumps or bilge pumps are open.

Q. What are the causes of feed pumps working poorly?

A. Generally, bad management. Either the pumps are not getting the water from the hot well regularly or the check valves on the boilers may be closed. Possibly the valves in the water end of the pump are out of order.

"The foregoing questions which I have quoted cover about the usual ground that is embodied in the examination given by the inspectors for your first papers. I do not mean to imply that you will get any of these particular questions when you go up for your tickets, but if you understand the principles upon which each of them is worked you ought to be able to pass any examination which they give you.

"This will conclude my course of lectures to you. I know I have not covered every subject in marine engineering, as many volumes have been written on the subject. I have endeavored to give you a good general idea of what you will have to know to be successful. You must not let up in your studies, as no man can keep up to date unless he is constantly studying. By that I do not mean that you should devote all your spare time to books, but at your ages you should give at least one hour a day of your time off watch to studying some of the many subjects connected with your business."

"Chief, can you recommend us some good books to get?" queried Pierce.

"Oh! yes, indeed I can; there are lots of good books which you can buy which will be very helpful to you. For example, there are several correspondence schools wherein for a small sum each month you can not only receive their courses of instruction, but you will get their text books into the bargain.

As a rule these books are excellently gotten up and will be of great value to you.

"For a good all-around text book on marine engineering it is doubtful if you can find any better than that written by Prof. W. F. Durand. He was once a sea-going engineer himself before he settled down in a college, so he knows both the practical and the theoretical sides of the business. Many of the best books on marine engineering are by English authors, as the whole world must admit that Great Britain has produced some of the ablest of engineers, particularly those in the marine branch. When you get further along in your business you should each buy yourself a copy of 'Reed's Engineer's Handbook.' All these books are, of course, very useful to you, but you can each write your own book on the subject."

"Gee! we're no highbrows," blurted out O'Rourke.

"You don't have to be to write the kind of book I'm going to tell you about.

"You should each get a good-sized blank book, made of serviceable paper for writing with ink and well bound. Whenever you see anything of interest in a text book or in any of the engineering papers you may read, copy it down in this notebook. If some older engineer tells you of a good method of making any particular kind of repairs, or gives you any information that you think will be valuable in the future, make copious notes of them in your book. As you grow older you will find that such a note book will become invaluable for reference, and it will increase in value to you every year that it is kept up. When you take your first examination write down all the questions you can remember, and work them out in your notebook. Even if they are not of much value to you after you have attained your license, they may help some young fellow who is coming after you later on.

"When these lectures which I have given you are published in book form, I am going to ask the publishers if they will print in the back of the book a lot of tables and useful information which every marine engineer should have handy. These will include tables of areas of circles, strength of materials, temperature of steam at different pressures, weights of different kinds of substances with which marine engineers have to deal, etc. I will also ask them to bind with the book a few blank pages, upon which you can write down any other bits of information you may run across which will be of value to you in your business.

"This will be my last regular talk with you boys as a class in the 'Floating School,' but I will be only too glad to help you with any of your problems whenever I have the opportunity. As it is about time for you to go on watch you had better turn to. I'll keep my eye on each one of you and see that you get a chance as soon as you can get your tickets."

"Chief," said Jim Pierce, who had been appointed spokesman of the class, "I cannot tell you how much all of us appreciate your kindness to us. Every one of us has benefited a great deal by the instruction you have given us, and we hope to show you by what we accomplish that your labors with us have not been lost. We want to ask you one parting favor before the 'Floating School' is broken up, and that is if you will do us the honor of going to dinner with your class when we reach New York."

"That's easy," laughingly replied McAndrew, "of course I will."

About ten days afterward the *Tuscarora* arrived in New York. The boys had talked over the dinner they were to have on every occasion when they came together.

O'Rourke insisted that it must be a "swell dinner," and that "no ordinary West Street restaurant chuck" would go. To this all very readily agreed, and it was decided that they would "blow themselves in a bang-up Broadway joint," as O'Rourke expressed it.

Promptly at the appointed hour the four sea toilers, arrayed in their best for the occasion, and accompanied by Chief McAndrew, sat down at a fashionable Broadway restaurant not far from Forty-second street. They were not, of course, togged out in evening clothes, as were most of the other men diners, but their clean-shaven faces, stalwart forms and generally spick appearance made them a very presentable group. O'Rourke had elected himself as master of ceremonies, but he was somewhat taken aback when the polite head waiter handed him several bills of fare, and asked if the party would be served à la carte or table d'hote. After getting his breath he replied:

"Aw, cut out that frog-eater's chatter and give us the best chow you've got in the joint."

McAndrew came to the waiter's rescue, and told him to serve the dinners table d'hote, afterwards explaining to his hosts that that meant they would have to pay only $1.50 each for the dinner, and that they would get a very good meal for less than it would cost them on the other plan.

What the boys lacked in style they made up in robust appetites, so as each course was served it was quickly disposed of with a noticeable lack of the usual picking and faultfinding indulged in by the habitues of such places. True, there was somewhat of a mix-up in the use of a multiplicity of knives, forks and spoons placed at each plate, but each was made to serve a good purpose, even if Schmidt did try to eat his fish course with a combined fork and spoon usually reserved for the ice cream.

The menu was printed in French, which caused much speculation as to the composition of the next course, and some grave doubts as to the course under consideration at the time.

O'Rourke had looked forward with great expectation to the viand described as "pommes de terre au naturel," and could not refrain from venting his disappointment when they were served, by shouting out, "Gee! they're nothing but plain old boiled spuds with some grass on them."

When the "café demi-tasse" was served at the conclusion of the meal, he nearly precipitated a small riot by demanding in loud tones that he be given "a man's size cup of coffee."

However, the influence of the good dinner soon calmed his ruffled temper, and when the real Havanas, not Savannahs, as O'Rourke announced he had been accustomed to smoking, were lighted, all was serene at the table.

Drawing a small package from his pocket, Pierce, in a few well-chosen and heartfelt words, presented it to McAndrew. Upon opening the package, McAndrew found, to his complete surprise, that it contained a handsome gold watch and chain. Upon the back of the watch was neatly engraved the following:

"To Chief Engineer James Donald McAndrew, with the highest esteem and gratitude of his pupils in the 'Floating School.' "

Quite overcome with this evidence of his pupils' appreciation of his efforts, McAndrew cleared his throat and said:

"Boys, what I have done for you was not with the hope of getting any such handsome reward as this, but from the interest which I take in young men who are anxious to advance themselves in their life work. Each one of you has the making of a good engineer in you, and I wish for you all every success in your efforts to advance. If my instructions serve to help you in accomplishing the first steps in your advancement I shall feel more than repaid. When you get further along, and want to try for higher grades of licenses, I shall, if you desire, and if conditions are such that we can all be together again, be only too glad to try to aid you in the same manner that I have attempted to do with the 'Floating School.' "

"We'll have to call it the 'Floating High School,' " responded O'Rourke, who was bound to have the last word.

THE END

Cutting Up the Wreck of a Steel Ship wfth the Oxy-Acetylene Torch

The tangled wreckage of the 1,800-ton steel freight steamer *Alum Chine,* which was destroyed by a dynamite explosion in the lower harbor of Baltimore on March 7, 1913, has recently been reduced to steel mill scrap with the aid of the oxy-acetylene cutting torch. This steamer was destroyed by an explosion of 300 tons of dynamite in its hold while loading a cargo for Panama. The violence of the explosion was so great that the entire forward part of the ship was blown away, the deck and upper works being reduced to bits and scattered over the harbor and adjacent shores for a radius of several miles, while the major part of the hull was thrown to the bottom in 33 feet of water. Pieces of steel 3 to 5 feet long were found at distances 2 to 3 miles from the wreck.

Fig. 1.—Hoisting Stern of Wrecked Vessel from Salvage Scow

A survey of the site showed that the after part of the hull, containing several hundred tons of steel, lay just outside the channel, covered by about 13 feet clear depth of water. The entire upper works, boilers and engines were gone, and the steel beams and plates were badly bent and twisted. It was necessary to remove the wreck in order to protect navigation, and a contract for this was let during the past summer to the Merritt & Chapman Derrick & Wrecking Company, of New York. An 80-ton steel floating derrick was detailed to the work. Divers were sent down to lay strings of dynamite, which were exploded under water so as to cut the hull into pieces of a size that could be handled by the derrick. The sections were then lifted onto a scow and towed to the dock and yard of the Southern Iron & Metal Company, of Baltimore, a concern which had purchased the steel from the wrecking contractors for disposal as steel furnace scrap. At the dock the floating derrick laid down the 25- to 40-ton pieces of the hull in a huge pile, as shown in the accompanying views.

Each large piece was a shapeless mass, with the plates, beams and members bent and crumpled. Rivets could not be removed to good advantage, since in many cases the flanges of angles or pieces of plate were bent over flat against them, preventing access to their heads. Most of the skin plating of the ship was ⅝-inch steel, running to greater thicknesses in the sheer, bilge and garboard strakes. The frames and stringers were deep, built-up sections of plate and angles. The condition of the steel was such that the expense of ordinary hand cutting would have been prohibitive, and the wreckage would have been a total loss had the oxy-acetylene process not been available.

A Milburn oxy-acetylene plant, mounted on a truck for portability, was supplied by The Alexander Milburn Company, of Baltimore. One torch operator was employed, long lines of gas hose being provided to allow sufficient freedom of movement about the wreckage, in order to attack it from points of greatest convenience. As fast as the pieces of steel of suitable size for handling were cut out by the torch they were loaded on wagons and then to freight cars for transportation to the mills.

It was impossible to establish a definite routine of dismantling the wreckage, both on account of the condition of the steel work and on account of inaccessibility. The work was simply started from the top or one side of the pile, and carried as far as convenient from that point, then resumed from some other point.

Owing to the irregularity of the work very little data were obtainable as to the rate of progress and other details. This was also complicated by the fact that the work was carried on only periodically, the operator being otherwise employed during a considerable part of his time.

Obituary

George Westinghouse, famous the world over as an inventor, engineer and manufacturer, died of heart disease in New York City, March 12, at the age of 67. Mr. Westinghouse was born at Central Bridge, Scoharie County, New York, Oct. 6, 1846. His first experience in mechanics was gained at the Schenectady Agricultural Works, which was established by his father in Schenectady, N. Y., in 1856. In 1863, when only 17 years old, Mr. Westinghouse enlisted in the army, and served in the infantry and cavalry, until in 1864 he was appointed third assistant engineer, United States navy. At the close of the war, he resigned from the navy and entered Union College, which he left at the end of the sophomore year to take up his career as an engineer. In 1865, he invented a device for replacing railway cars upon the track, which was manufactured at Troy, N. Y. Soon after that, what is generally recognized as his greatest invention, the air brake, was brought out. The first patent for the air brake was issued April 13, 1869, the Westinghouse Air Brake Company was formed July 20 and a factory was established in Pittsburg in 1870. At first Mr. Westinghouse had difficulty in introducing the air brake, but he was continually perfecting the device, until in 1886 he brought out the quick action brake, with its triple valve. The introduction of switch and signal systems operated by compressed air, controlled by electricity, soon followed the introduction of the air brake, and in 1885 Mr. Westinghouse began to develop the alternating current system, which has meant so much to the industrial, manufacturing and commercial world in the last generation. It was Mr. Westinghouse who introduced the Parsons turbine in the United States. He has long been interested in the question of ship propulsion and has brought out, in collaboration with the late Rear Admiral Geo. N. Melville and John H. MacAlpine, the highly ingenious reduction gear for turbine-driven ships, which is now being applied to both naval and merchant vessels. Mr. Westinghouse received decorations from the French Republic, the King of Italy, and the King of Belgium. He was the second person to receive the John Fritz medal, and in 1912 he was awarded the Edison medal by the American Institute of Electrical Engineers. Last December he received the German Grashof medal.

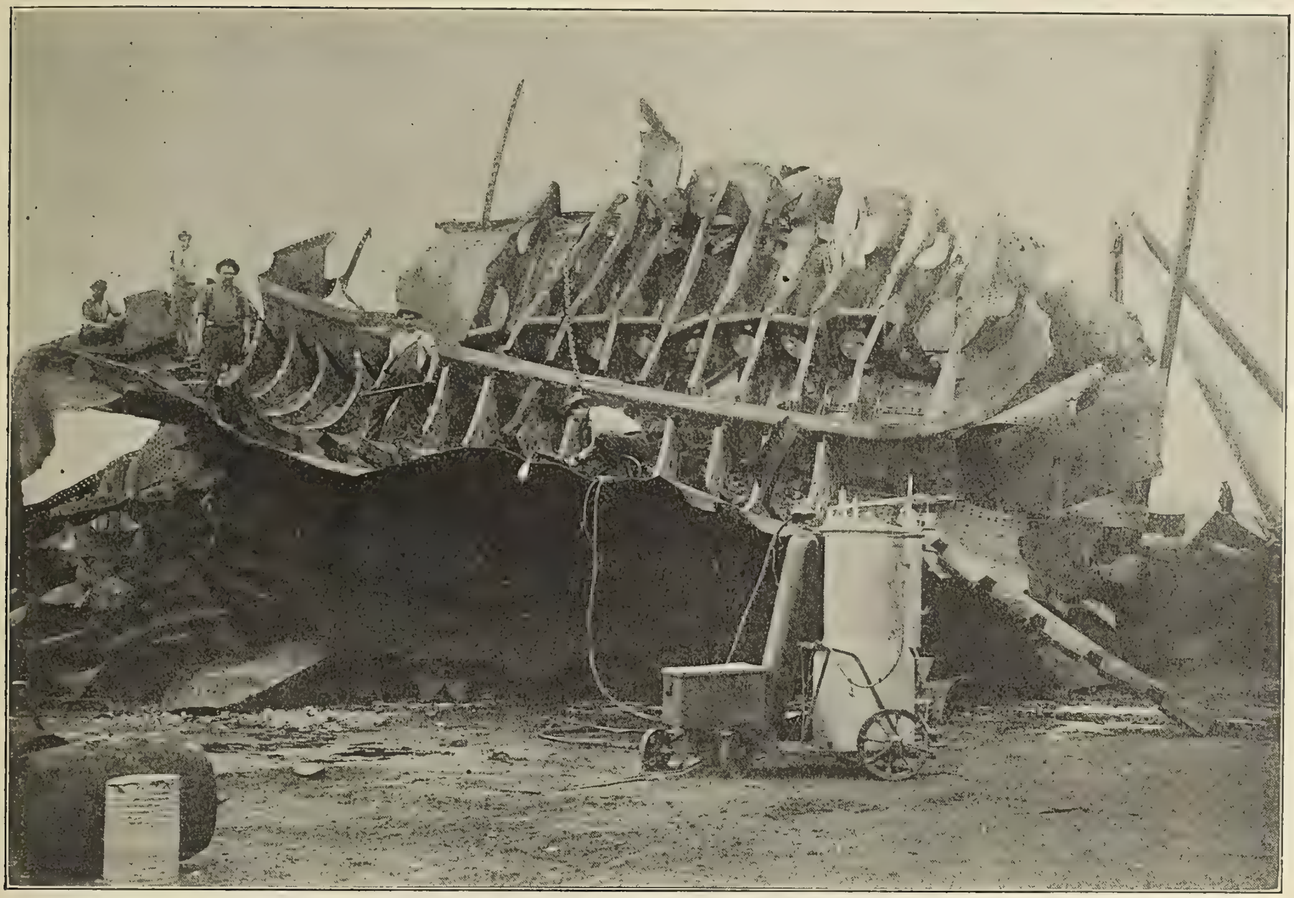


Fig. 2.—Torch Operator Cutting Apart Bottom Plating of Wrecked Vessel

Fig. 3.—Cutting Bent and Twisted Plates with Oxy-Acetylene Flame

The Design of Merchant Ship Forms

A Systematic Method for Correlating the Various Factors in Determining the Best Form for a Merchant Ship

BY PETER DOIG

Within late years there has been published a considerable amount of experimental data on the best forms for ships of the usual proportions, fullnesses and speeds current in merchant vessel practice, but, so far as the writer is aware, there has been made public no attempt to standardize these into a systematic method enabling the naval architect to fix on shapes which will ensure easy propulsion and be consistent with the requirements of the other elements in design. Hitherto, for those without the aid of model experiment, the usual procedure has consisted in following the "lines" of some previous satisfactory ship.

While obviously the best under the circumstances, this method has at least one defect, which may be responsible for some disappointment in performance. For it may happen that the type vessel followed owes its relative success to a good propulsive result rather than to an easily propelled hull. Hence, if the new ship should happen to have a combination of power, revolutions of screw and speed less favorable to high-propeller efficiency, the former good propulsive performance will not be repeated and the all-around result as an economically-driven hull will not be so satisfactory. This is more likely than ever to happen at the present time, which is witnessing frequent transitions from one form of motor to another, with accompanying differences principally in number of screws and their revolutions, and consequent change in propeller efficiency. The added importance of some guide to good forms is thus evident.

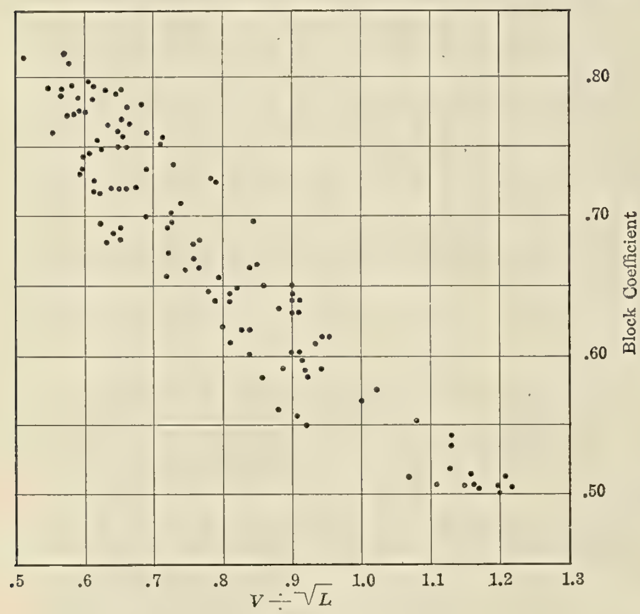


Fig. 1

The model towing investigations of Froude, Taylor and Sadler have put before the shipbuilder a body of information from which a good shape of hull for any normal design of ship can be obtained with some little care. One of the first points which strike the student of these results is that there is no quality of "form" (by which is meant the nature of the sections of the ship's underwater body) which is good at all speeds; or, in other words, there is no ship shape of "minimum resistance." Convexity, straightness or hollowness of sectional outline may any of them be best for a particular fullness and speed, but far from it at some other combination of these factors.

To bring the problem within reasonable dimensions it therefore appears desirable at the outset to connect the two factors of fullness of form and speed at which a given fullness is usually driven in good practice. In Fig. 1 have been plotted the "block coefficient" (C_b) and speed-length ratios $\left(\text{speed in knots} \div \sqrt{\text{length}} \text{ or } \frac{V}{\sqrt{L}}\right)$ of a large number of merchant craft ranging in length from 250 feet to 850 feet and in speed from 10 knots to 25 knots. Almost without exception these are found in a well-marked zone, which has a breadth of from 0.15 to 0.20 expressed in speed-length ratio. The extremes of this zone may be taken to be those which practical experience has sanctioned as the economical limits for merchant vessels.

Further study of these model results shows that the virtue or reverse of any quality of form persists for a range of speed which is generally large enough to cover the range of $\frac{V}{\sqrt{L}}$ appropriate to any particular fullness in Fig. 1; and it is also to be noticed that within the usual limits of proportions in merchant craft the best shapes are not materially affected by changes in the ratios of length to breadth or draft to breadth. For normal vessels it would thus appear necessary to relate to fullness alone such qualities as may be deemed worth consideration in a standardized method of design.

The factors defining a good form are based principally on the fact enunciated in the following quotation from R. E. Froude's paper on cruiser forms (Trans. I. N. A., 1904):

"The resistance of a form is determined solely by the curve of cross-section areas, together with the extreme beam and the surface waterline of the forebody; if these are adhered to, the lines may be varied in almost any reasonable way without materially altering the resistance."

In the present treatment of the question, the curve of the ratios of cross-section area to mid area or "prismatic curve," and the shape of the load waterline, are adopted as the standards to which the method is intended to lead.

With a given set of dimensions it is evident that, if the load waterline breadth and area of transverse section at each station in the vessel's length are known, the nature of the transverse outlines is to some extent defined and an approximate form adumbrated. As these are, moreover, the most important features in determining an easily-driven shape, once proportions and fullness have been decided on, the value of a method giving them satisfactorily should be evident.

In constructing methodical curves for the sectional areas and load waterline half breadths of good forms the writer has taken into consideration the published results of Taylor ("Parallel Middle Body, Influence of Form on Resistance," etc.), Sadler ("Disposition of Displacement in Ships of Moderate and Full Forms") and Froude (various papers on "Cruiser Forms," etc.). For several fulnesses, sets of "ideal" lines were drawn adopting normal values of sheer and rise of floor, and to the average proportions of length, breadth and draft, as indicated empirically by the plotting of these ratios for the

ships used in constructing Fig. 1. These were then adjusted to suit the other important elements of merchant ship design, such as stability, ability to maintain speed in a seaway, longitudinal disposition of volume for cargo holds, deck space at ends, etc., so far as these affect underwater shape; and final "practical" sets of lines derived which were then modified for the range of longitudinal position of center of buoyancy necessary to cover practice.

In constructing these the normal values of mid-area coefficient C_m (immersed sectional area amidships ÷ breadth multiplied by draft), and the ratio of breadth to draft, have been taken for varying prismatic coefficients as follows:

TABLE I.

C_p	C_m	*Breadth ÷ Draft*
.5	.92	3.6
.6	.94	2.7
.7	.96	2.2
.8	.98	1.9

TABLE II.

Prismatic Coefficient.	Station.										
	½	1	2	3	4	5	6	7	8	9	9½
.52	.033	.117	.369	.642	.878	1.000	.916	.680	.404	.185	.084
.54	.051	.146	.399	.664	.890	1.000	.926	.711	.443	.207	.094
.56	.070	.174	.427	.687	.901	1.000	.937	.745	.484	.227	.102
.58	.089	.203	.456	.709	.911	1.000	.948	.782	.527	.245	.108
.60	.106	.230	.485	.732	.922	1.000	.959	.822	.572	.259	.111
.62	.121	.252	.514	.754	.934	1.000	.971	.862	.618	.271	.112
.64	.137	.272	.544	.778	.943	1.000	.982	.897	.666	.283	.112
.66	.152	.290	.575	.805	.955	1.000	.992	.926	.712	.300	.114
.68	.164	.310	.608	.835	.968	1.000	1.000	.950	.753	.325	.122
.70	.176	.331	.644	.868	.982	1.000	1.000	.969	.792	.358	.138
.72	.187	.352	.683	.904	.993	1.000	1.000	.982	.826	.399	.161
.74	.200	.379	.727	.931	.998	1.000	1.000	.992	.857	.451	.194
.76	.215	.415	.773	.953	1.000	1.000	1.000	.995	.881	.513	.238
.78	.232	.468	.819	.967	1.000	1.000	1.000	.997	.902	.586	.293
.80	.250	.524	.858	.978	1.000	1.000	1.000	.998	.920	.648	.347
.82	.275	.588	.892	.989	1.000	1.000	1.000	1.000	.941	.705	.406
.84	.309	.655	.921	.997	1.000	1.000	1.000	1.000	.963	.757	.466

TABLE III.

Prismatic Coefficient.	Station.										
	½	1	2	3	4	5	6	7	8	9	9¼
.52	.051	.146	.396	.666	.889	1.000	.909	.648	.373	.162	.072
.54	.069	.174	.426	.689	.900	1.000	.918	.679	.408	.184	.083
.56	.088	.202	.457	.713	.910	1.000	.928	.712	.446	.205	.092
.58	.106	.230	.489	.737	.923	1.000	.938	.747	.486	.224	.100
.60	.123	.255	.521	.762	.934	1.000	.948	.784	.528	.241	.106
.62	.137	.276	.555	.787	.946	1.000	.960	.821	.571	.255	.109
.64	.151	.295	.586	.812	.957	1.000	.970	.856	.615	.267	.109
.66	.165	.316	.619	.839	.968	1.000	.979	.887	.659	.282	.111
.68	.178	.338	.655	.868	.979	1.000	.988	.915	.701	.302	.117
.70	.192	.365	.693	.897	.989	1.000	.995	.938	.741	.328	.127
.72	.205	.394	.732	.925	.996	1.000	.999	.957	.778	.363	.145
.74	.222	.431	.773	.949	.999	1.000	1.000	.972	.812	.407	.171
.76	.242	.477	.813	.967	1.000	1.000	1.000	.981	.841	.459	.206
.78	.267	.534	.853	.981	1.000	1.000	1.000	.987	.868	.520	.249
.80	.294	.592	.889	.989	1.000	1.000	1.000	.992	.892	.580	.296
.82	.329	.650	.921	.995	1.000	1.000	1.000	.996	.916	.638	.347
.84	.375	.707	.949	.998	1.000	1.000	1.000	.999	.938	.692	.403

TABLE IV.

Prismatic Coefficient.	Station.										
	1/2	1	2	3	4	5	6	7	8	9	9 1/2
.52	.070	.175	.423	.690	.900	1.000	.901	.616	.342	.139	.060
.54	.089	.203	.456	.714	.911	1.000	.910	.648	.375	.161	.072
.56	.108	.231	.489	.740	.922	1.000	.919	.680	.410	.184	.083
.58	.125	.257	.523	.766	.934	1.000	.929	.713	.447	.205	.092
.60	.139	.280	.559	.792	.947	1.000	.939	.746	.484	.223	.099
.62	.150	.298	.594	.818	.959	1.000	.949	.780	.523	.237	.104
.64	.166	.319	.630	.847	.973	1.000	.958	.814	.563	.251	.108
.66	.179	.342	.665	.874	.983	1.000	.967	.848	.606	.264	.110
.68	.192	.368	.703	.901	.990	1.000	.976	.879	.650	.280	.110
.70	.207	.399	.743	.926	.995	1.000	.984	.907	.692	.301	.117
.72	.223	.437	.782	.946	.998	1.000	.992	.931	.731	.328	.130
.74	.243	.483	.818	.963	1.000	1.000	.998	.951	.768	.364	.149
.76	.269	.538	.852	.981	1.000	1.000	1.000	.966	.802	.405	.174
.78	.300	.599	.885	.994	1.000	1.000	1.000	.978	.834	.455	.205
.80	.336	.657	.918	.999	1.000	1.000	1.000	.986	.863	.510	.244
.82	.382	.712	.949	1.000	1.000	1.000	1.000	.991	.890	.568	.290
.84	.441	.760	.977	1.000	1.000	1.000	1.000	.994	.913	.627	.340

Tables II, III and IV are constructed to give the sectional areas in terms of midship area, at stations on every tenth of the ship's length and on intermediate half-ordinates at each end. They have been figured for positions of center of buoyancy at one percent of vessel's length forward, amidships, and one percent aft, respectively. By linear interpolation or exterpolation any intermediate or external value of prismatic coefficient and position of center of buoyancy can be worked to.

The author recommends the use of the above values of C_m where possible; but some deviation from them is practicable, although excessive rise of floor or fineness of bilge is not contemplated for use with Tables II, III and IV.

(To be concluded.)

The Stability of Submarines While Filling Ballast Tanks*

BY MARINESCHIFFBAUMEISTER WERNER

It is essential that both designers and builders as well as naval officers and engineers have a clear conception of the stability characteristics of submarines before attempting to build or command such craft.

For the boat in the light or emerged condition, as also when fully submerged, the problem is simple. In the former case, *i. e.*, with ballast tanks empty, the stability does not differ from that of an ordinary vessel. Submerged, *i. e.*, with the ballast tanks completely filled, the stability, or righting moment, is always equal to the product of the weight of the boat into the horizontal projection of the distance between the center of gravity and center of buoyancy. Mathematically expressed, it is: Moment of statical stability = weight of ship × distance between *C. G.* and *C. B.* × sine of the angle of inclination.

In order that this moment may not become zero, or, in other words, in order that a righting tendency may always exist, the center of gravity in the fully submerged condition must always lie below the center of buoyancy.

During the process of filling the ballast tanks the conditions are not so simple. In technical literature this case is usually passed over with the remark that the designer must take care that at the instant "stability of form" disappears during submergence, the boat has sufficient "stability due to weight." The converse of this requirement, namely, that with diminishing weight stability during emergence there must be sufficient form stability is equally true. This proposition and its converse are too general to indicate fully what takes place during the process of filling or emptying the ballast tanks. The following will therefore deal mainly with determining what constitutes "sufficient" stability, at the same time demonstrating the truth of two propositions, viz.:

1. The presence of "initial weight stability," *i. e.*, the center of gravity located below the center of buoyancy, does not necessarily ensure, during the process of flooding the ballast tanks, that the boat, in all practical longitudinal and transverse inclinations, possesses a righting tendency.

2. The presence of "initial form stability" in the upright condition does not always ensure, with absence of weight stability, during the process of flooding, a righting tendency of the boat when inclined.

The following notation will be employed:

P = weight of ship.
V = volume of displacement.
J = moment of inertia of the water plane about the center line of the ship (axis of symmetry).
J_1 = moment of inertia of the free surface of the ballast water, at any instant of flooding, about the center line of the ship.

* Translated from *Marine Rundschau* by Louis Eckert.

M = metacenter of the ship when upright.
$M\ \Phi$ = metacenter of the ship when inclined Φ degrees.
B = center of buoyancy in the upright condition.
$B\ \Phi$ = center of buoyancy in the inclined condition.
G = center of gravity.
l = righting lever.
γ = specific gravity of the sea water.

It is well known that the metacentric height $G\ M$ of a

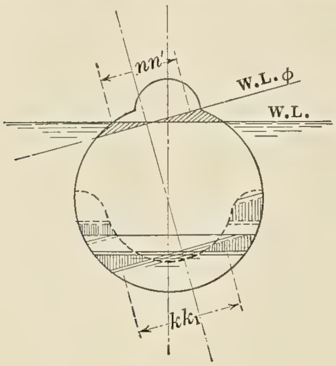


Fig. 1

floating body carrying free water in its interior is given by the equation

$$G\ M = \frac{J - J_1}{V} + B\ G;\ + \text{ or } - B\ G,$$

according as B lies above or below G. Proposition 1 assumes $B\ G$ positive, $G\ M$ therefore remains positive so long as

$$\frac{J - J_1}{V}$$

remains positive, or in case $J_1 > J$ that $\frac{J - J_1}{V} < B\ G$.

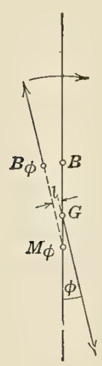


Fig. 2

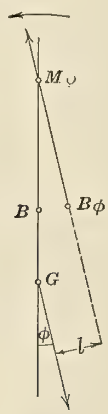


Fig. 3

During the process of flooding, the free water surface in the ballast tanks gradually increases, reaches its maximum and becomes equal to zero when the tanks are completely full. The water plane, on the contrary, decreases, and finally becomes likewise equal to zero. The free water surface, toward the end of the process of flooding, generally becomes greater than the corresponding water plane, $J - J_1$ becomes therefore negative. In case

$$B\ G < \frac{J - J_1}{V},$$

then $G\ M$ also becomes negative, *i. e.*, the boat, when inclined by outside forces such as may be produced by a seaway, unequal filling, etc., not only has no righting moment but will continue to incline until $G\ M\ \Phi$ again becomes positive. That the latter condition must always set in in modern types of submarines will be shown in the considerations that follow. Whether this occurs sooner or later depends on the form of hull.

Fig. 1 shows the cross section of an earlier form of "single-hull boat, the dotted line giving the control of the ballast tank of the later "single-hull" boats. Assume the boat in-

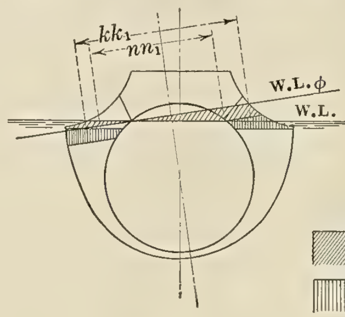


Fig. 4

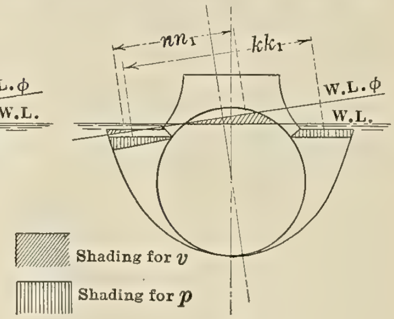


Fig. 5

clined through the angle Φ by some extraneous force; let $n\ n_1$ denote the shift of the center of gravity of the wedge v of the volume of reserve displacement; $k\ k_1$ the shift of the center of gravity of the wedge p of the free water ballast; then the resulting side shift of the center of buoyancy B from its mid position to $B\ \Phi$ is given by

$$B\ B\ \Phi = \frac{\gamma\, v \cdot n\, n_1 - p\ k\ k_1}{\gamma\, V}.$$

The proof of this may be assumed from the theory of naval architecture.

When the moment $\gamma\ v\ n\ n_1 < p\ k\ k_1$, as shown in Fig. 1, the center of buoyancy shifts away from the side toward which the ship is inclined and $B\ M\ \Phi$ becomes negative. Now as soon as $M\ \Phi$ falls below G, mathematically expressed $B\ M\ \Phi > B\ G$, an upsetting couple $P\ l$ (Fig. 2) will act, increasing the inclination until the ballast tank top causes the free surface of the ballast water to become smaller and smaller. For

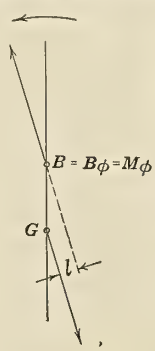


Fig. 6

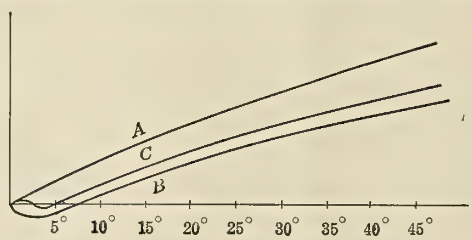


Fig. 7

the tank form indicated by the dotted line, Fig. 1 shows the condition in which the limit has already been reached beyond which the couple begins to act in the contrary direction and a righting tendency sets in, for water can now no longer shift over ($p\ k\ k_1 = o$).

When the moment $\gamma\ v\ n\ n_1 > p\ k\ k_1$, a righting couple will act (Fig. 3), since the center of buoyancy $B\ B\ \Phi$ shifts toward the side to which the boat is inclined. Figs. 4 and 5 show the cross sections of two "double-hull" boats, differing from each other only in the form of the ballast tanks. In Fig. 5 it will be noticed that, for the instant of flooding indicated, the free water surface is considerably larger than the water plane. The boat is for the time being without initial stability of form, but at the inclination Φ it has already reached the limit be-

yond which $G M \Phi$ again becomes positive, for then the fully-immersed tank is completely filled, while with the boat of Fig. 4 this limit is reached only after greater inclination.

When $\gamma v n n_1 = p k k_1$ (Fig. 6), then $B B \Phi = o$ and $G M \Phi = B G$; *i. e.*, the boat has stability due to weight alone. If the ballast water were free to shift like bilge water, the case might arise in which, with a free surface sufficiently large and weight stability very small, the limit above mentioned would not set in, and the boat would founder.

The form of the ballast tank is therefore of great significance as regards magnitude of and variation in $G M \Phi$. The variation in the moment of statical stability $P l$ for any assumed condition of flooding, is most readily seen from the usual graphical representation of the righting levers of statical stability (Fig. 7). Such a curve, it must be noted, shows the variation for only one condition of flooding, being different for every other condition. For the light, or fully emerged condition, the curve will be positive throughout, the same being true of the fully submerged condition, but with the difference that in the former case the shape is that of a

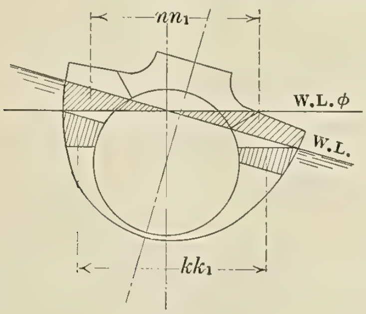


Fig. 8

modified sinoid, depending on the form of hull above water, while in the latter case it is a true (mathematical) sinoid. Curve *A*, Fig. 7, shows the variation in stability of a boat possessing a righting tendency throughout, such as is the case with any properly designed surface vessel. Curves *B* and *C* illustrate the variation in stability for the cases in which, on the one hand, there is negative initial stability, and on the other hand, though positive initial stability, yet followed by a short period of negative stability. The assumption in all cases is a positive $B G$. From Fig. 7 it is evident that, although $B G$ is positive, this does not signify that the curve of righting moments for larger inclinations is necessarily positive throughout, even with the presence of positive initial stability as shown in curve *C*.

In flooding the tanks in a seaway it may therefore happen that the boat takes a sudden lurch to the limiting angle at which the righting arms again become positive. Taking into consideration the dynamical influence of the seaway and the free surface of the ballast water, a considerable tilt beyond this limiting angle must even take place. This, however, is not attended with any danger of foundering, since beyond the limiting position quickly-increasing righting moments at once set in. Besides this, the condition of flooding is constantly changing and the free water surface diminishing, so that the limiting angle gets smaller and smaller, necessarily reaching zero when the ballast tank is completely filled.

The calculation of the arms of the righting moments for longitudinal and transverse inclinations during flooding is therefore of great importance for judging the qualities of a submarine; to know that $B G$ is positive is not sufficient in itself for this purpose. From the curve one sees at a glance what peculiarities one may expect during flooding, and at what point the limiting angle is reached to which the boat might eventually incline; one realizes the fact of the inability of the boat to founder. But, above all, it also shows that even mistakes in the flooding procedure, and consequent unequal filling, do not signify any immediate danger. It must again be pointed out, however, that up to now all considerations presupposed the existence of stability due to weight, *i. e.*, that the center of gravity lies below the center of buoyancy.

We come now to the converse of the original proposition, for which the condition was imposed that there be absence of weight stability, *i. e.*, $B G = o$, or negative, and $B M$ always positive, therefore $J > J_1$ for the mid position. It will be realized from Fig. 8 that the case might arise in which at large inclinations, brought about, let us say, by improper flooding or a seaway, $\gamma v n n_1 < p k k_1$, therefore $B B \Phi = o$, or else the center of buoyancy shifting away from the side toward which the boat is inclined, thereby bringing into play a couple tending to increase the inclination. It will also be seen that here the limiting position, at which no more water can shift over, does not set in till later on, since the tanks are

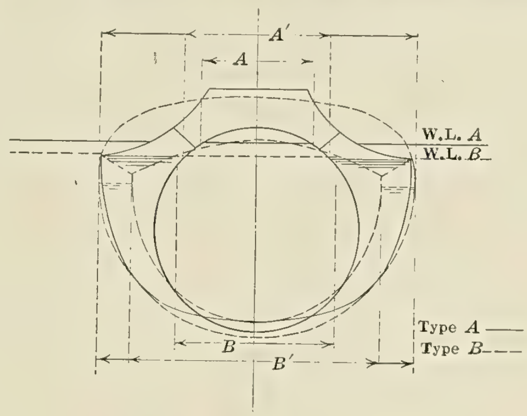


Fig. 9

considerably less filled than in the cases heretofore considered. Only after further flooding does the center of buoyancy rise and weight stability begin to act. In blowing or pumping out the tank, on the contrary, the moment $p k k_1$ becomes smaller, $B \Phi$ begins to travel toward the inclined side, and the boat again gets back its righting tendency. It is therefore advisable, also for these conditions of flooding, in which there is apparently sufficient stability of form for the upright position, to work out the curve of righting levers as indicated in Fig. 7.

Let us now consider the deductions which the designer may draw from these:

1. In the light condition the boat should already have, if possible, stability due to weight, *i. e.*, $B G$ positive.

2. The form of the ballast tanks must be such that the limiting position beyond which no more water can shift over sets in at small inclinations; furthermore, that the free surfaces of the ballast water are kept comparatively small, and that the tanks themselves have small leverages in regard to the axes through the center of gravity. The subdivision, longitudinally, to be so arranged that two adjacent tanks may remain empty while flooding and full while blowing the tanks (errors in the flooding maneuver or possible consequence of a collision which has affected the two compartments), without giving to the boat a larger inclination than is admissible in consideration of ease of handling.

Separating or partitioning off the port from the starboard tanks should really have no influence, since with kingstons and vents open they are in communication through the water and air outside. It is evident, however, that this communication would only then be complete if the rise and fall of the water level in the tanks could take place at the same rate as that with which the water outside rises and falls. Such, naturally, is not at all the case, the areas of the kingston and vent openings being too small to admit of this. It may even

be assumed, to a certain extent, that for the short time normally required in flooding, the water in each side shifts over, so to say, "in itself," and that hence only the moments of inertia of the free surfaces about their own axes are effective. If, however, the operation of flooding is purposely prolonged, so that the boat remains for some time with tanks only partially filled, even the partitioning off of the tanks will not prevent a gradual equalizing of the water levels through the medium of the outer water and air. Nevertheless, such division will generally be accompanied by a considerable improvement in stability.

The requirement of proposition 1—positive *B G* in the light condition—is probably always fulfilled in the "single-hull" boats, if only on account of their small stability of form. Due to their peculiar distribution of weight this requirement is also relatively easy of attainment, though it may require at least some fixed ballast. With "double-hull" boats, which in their distribution of weights somewhat resemble torpedo boats, in fact the more so the larger they become, the problem is more difficult. Outer hull and superstructure materially raise the center of gravity, to compensate for which a considerable amount of fixed ballast is required. In order to avoid too great an amount, the designer will naturally resort to the expedient of allowing a negative *B G* in the light condition, at the same time giving to the ballast tank, as far as possible, such a form as will ensure the center of buoyancy passing above the center of gravity during the early stages of flooding. In Figs. 4 and 5 we have already seen the influence of the form of ballast tank on stability at inclinations. It would seem that the "double-hull" boat with cylindrical inner hull of circular cross section, type *A* in Fig. 9, is somewhat inferior in this respect to the Laurenti boat, type *B*. A mere glance at the illustration shows that the greater breadth of the upper part of the pressure hull decreases the free surfaces of the ballast tanks, and that the larger quantity of water lies in the lower part of the tank. If one compares the two types in conditions of flooding corresponding to approximately equal amounts of reserve buoyancy, one finds that type *A* has a smaller water plane—*A* as against *B*—and broader free surfaces in the tanks (not yet quite full), *A'* as against *B'*. Compared with the moment of inertia of the heavily drawn portion of the ballast water surface *A'* we have that of the surface *B'*. Evidently type *B* will in this condition of flooding be superior to type *A* as regards initial stability of form.

Change in breadth over outer hull in double-hull boats has little influence on stability during flooding, as the broadening of the water plane and the increase in the free surface go hand in hand. The breadth therefore should not be made greater than is necessary to give the boat the metacentric height found from experience to be desirable in the fully emerged or light condition.

The requirement—small leverages of the tanks about the axes through the center of gravity of the boat—will be harder to comply with, both longitudinally and transversely, in the "double-hull" than in the "single-hull" boats. In the latter the tanks are inside, and extend from one-half to two-thirds the boats' length amidships. In the former they lie outside, hence farther removed from the center line plane, and usually reach as far as the ends of the ship, where they considerably affect the trim. By careful observations of trim during the operation of flooding in smooth water this action may, in a measure, be avoided; in a seaway, however, it will make itself very much felt. It is the business of the designer to so shape the ends that this action is as far as possible precluded.

Accidents to submarines which can be laid to want of stability have so far never come to knowledge, which goes to prove that all boats of the present day are, as a matter of fact, "non-capsizable" so long as the pressure hull is intact. But the larger the displacements and engine powers become the more will the relative position of the centers of buoyancy and displacement approach that of torpedo boats, and the less will it be possible, as mentioned above, to start out with the center of gravity lying below the center of buoyancy without unduly increasing the amount of fixed ballast. The shape and position of the ballast tanks therefore will require in increased measure the attention of the designer.

Passenger Motor Ship Fohr Dagebull

BY J. RENDELL WILSON

On the Continent of Europe there are numbers of Diesel-engined craft in service, the existence of which is not generally known in the ordinary course of events. It is rather difficult to realize this now, as the great interest taken in this type of motor ship has been the cause of the publication of details of nearly every vessel as soon as she is launched. Lately, however, I have unearthed a number of these boats, such as the M. S. *Kaiser, Kommandatur Helgoland* and the *Delphin,* and now I am enabled to give particulars of the *Fohr Dagebull,* a passenger motor ship that has been working between islands in the North Sea, Wyk, and the mainland for over a year with excellent results. Up to the time of writing

Passenger Motor Ship *Fohr Dagebull* in Service on the North Sea

no details have been published in the English language, so the following no doubt will be of interest:

The *Fohr Dagebull* is owned by the Wyk Steamship Company, of Wyk, who run a large fleet of steamers. In the past the company have endeavored to equip their vessels with modern machinery, and all the latest marine inventions are carefully watched, consequently they were among the first group of Western Europe owners to have a Diesel ship built. I understand that they have also experimented with gasolene (petrol) motors and low compression heavy oil engines and all classes of steam engines; but the Diesel has been found to be the most economical of all classes of propulsive machinery. In view of the difficult navigation of the waters in which the boat works considerable engine flexibility is necessary, so this unbiased report should be noted by other owners, particularly by those who are doubtful of adopting Diesel power.

She was placed in service in June, 1912, having been built at the yard of H. C. Stülken & Söhne, Steinwerder, Hamburg, to the German Lloyd class W. Her general dimensions are as follows:

Length	100 feet 9 inches
Breadth	19 feet 6 inches
Draft	4 feet 3 inches
Brake horsepower	120
Speed	10 knots

It will be noticed that the draft is rather light; but this is necessary, as it is the maximum for the district she serves. Yet she has been found to be very stable and seaworthy. In addition to carrying passengers she transports general cargo and cattle. The forward mast is fitted with a derrick, and at aft there is a promenade deck for the passengers. Except for the absence of smoke there is nothing in her appearance to distinguish her from a steamer; but the actual difference will be realized when I say that she carries sufficient fuel in her tanks for twelve months' working of eight hours per diem at 10 knots. Fuel cost comparisons with a steamship of similar size on the same route are obtainable, and while *Fohrs Dagebull's* fuel only costs 0.018 MK. per effective horsepower-hour, the steamer's coal consumption costs 0.03 MK. per effective horsepower-hour.

The propulsive machinery of this motor ship consists of a six-cylinder (two maneuvering and four working cylinders) Benz-Hesselman Diesel engine of the direct-reversible, single-acting type, developing 160 indicated horsepower at 300 revolutions per minute. This type of motor is similar in design to the Polar-Diesel, and was constructed by Messrs. Benz & Company, of Mannheim, Germany, under license. The engine room is equipped with all the usual auxiliary plant for operating the winches and main engine, and there is a separate motor-driven electric lighting set.

Launch of the Battleship Oklahoma

The first of the United States battleships authorized in 1911 was launched at the yards of the New York Shipbuilding Company, Camden, N. J., March 23, and christened the *Oklahoma* by Miss Lorena Jane Cruce, daughter of the Governor of Oklahoma.

The vessel is 583 feet long overall, 575 feet long on the waterline, 95 feet 3 inches beam and 28 feet 6 inches mean draft, with a normal displacement of 27,500 tons, and a full load displacement of 28,400 tons. Propulsion is by twin screws driven by two four-cylinder triple-expansion engines, with cylinders 35, 55, 78 and 78 inches diameter and 48 inches stroke, supplied with steam from twelve Babcock & Wilcox watertube boilers. The total indicated horsepower is 24,800, designed to give the ship a speed of 20.5 knots.

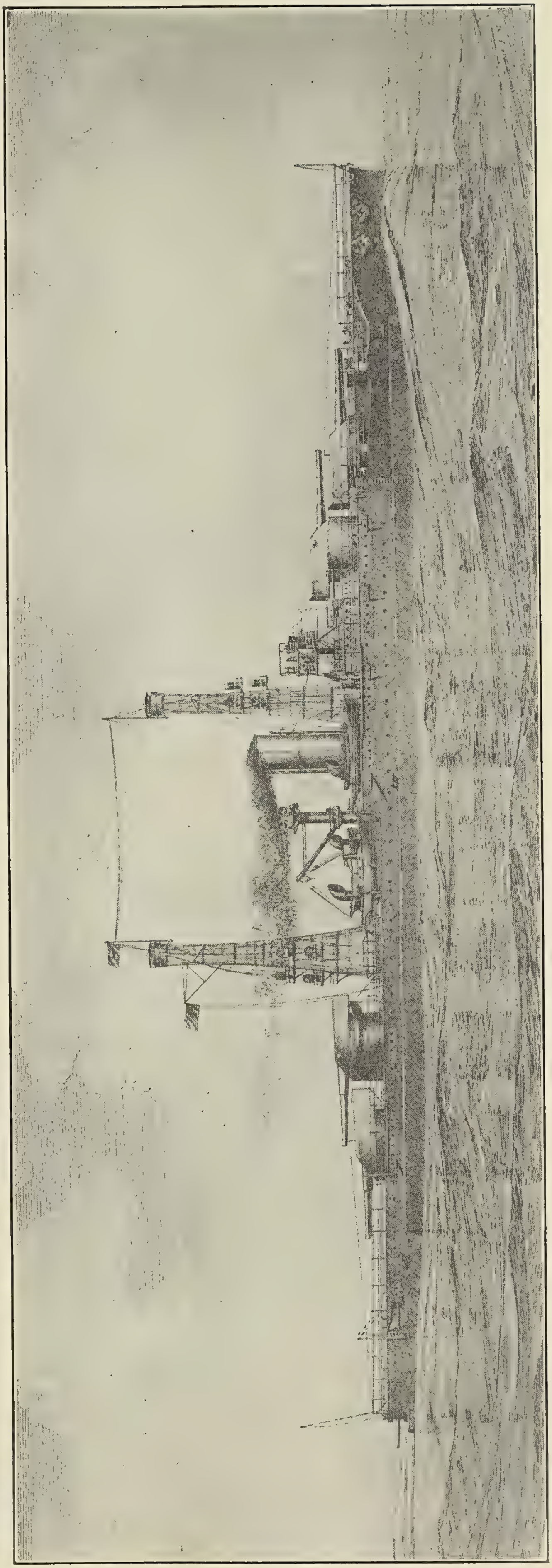
Oil fuel is used exclusively, and the ship's bunkers have a total capacity of 598,400 gallons. The total heating surface of the boilers is 48,000 square feet, and the weight of the machinery, 1,900 tons.

The main battery consists of ten 14-inch guns mounted in four turrets on the centerline of the ship. The forward and after turrets carry three guns each, while the other two turrets have only two guns each. They are, however, mounted at a higher level so that they can fire directly over the triple gun turrets. Thus the ship has a broadside fire of ten 14-inch guns and an ahead and astern fire of five 14-inch guns.

The secondary battery consists of twenty-one 5-inch guns, four 3-pounders, two 1-pounders and four submerged 21-inch torpedo tubes.

The main armor belt is 13½ inches thick amidships, and is 17½ feet wide, extending 8½ feet below the load waterline. The triple turrets are protected by 18-inch and 9-inch armor and the double turrets with 16-inch and 9-inch armor. The ends of the vessel are unarmored. The ship has a single funnel protected at the base with 13½-inch armor. The vulnerable parts of the ship are further protected with a 3-inch protective deck.

The *Oklahoma's* sister ship, which will be named the *Nevada*, is being built at the Fore River shipyard, Quincy, Mass. She will be fitted with Curtis turbines and Yarrow boilers; the two vessels will, therefore, furnish a further opportunity for the United States navy to investigate the merits of opposing types of propelling machinery.



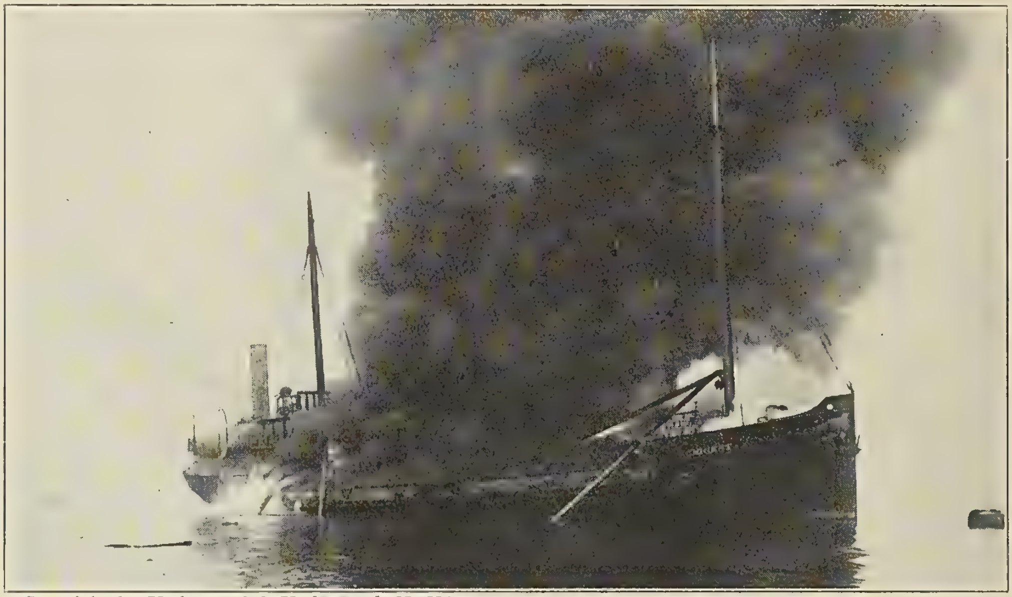
United States Battleship *Oklahoma*, Launched by the New York Shipbuilding Company, Camden, N. J., March 23. (Drawing Made from Designs of the Vessel, Showing How She Will Appear When Completed)

Severity of Winter Weather at Sea as Revealed by the Camera

Hardships and dangers at sea are never more formidable than in the winter months, especially on the North Atlantic, where gale follows gale and the prevalence of heavy storms taxes the skill and courage of the hardiest navigators and engineers to the utmost.

A striking illustration of the severity of a winter gale is given in the photograph on the opposite page, which shows the United States battleship *Vermont*, with all decks awash from stem to stern, fighting her way through a mid-winter storm. Seldom is the seaworthiness of a big steel warship better portrayed than in this case. With sailing ships, even when of large size, the result of a severe storm is likely to be the destruction of the vessel and the loss of her crew. In Fig. 4 can be seen the wreck of the Italian bark *Castagne*, which went ashore near Wellfleet on February 18. Four men were frozen to death in the rigging of this vessel, while eight survivors were brought to Boston.

Another unusual disaster occurred at Portland, Ore., on March 12, when a big water front fire caused the loss of over a million dollars' worth of property. Few of the vessels in the locality of the fire escaped without injury, and in Fig. 1 is shown the spectacular fire which destroyed the American steamer *Cricket*, which was loaded with asphalt. Fire swept the vessel from stem to stern, and she became a total loss.



(Copyright by Underwood & Underwood, N. Y.)

Fig. 1.—American Asphalt Steamer *Cricket* Destroyed by Fire at Portland, Ore., March 12

Although less dangerous but scarcely less troublesome are the obstacles encountered in the winter months on account of ice.

Fig. 2 shows the mantle of ice that frequently covers the hull and rigging of incoming vessels after a stormy voyage, while Fig. 3 shows the ineffectiveness of a powerful ice-breaking steamer after an attempt to navigate an ice-bound river in Canada.

(Photographs by Underwood & Underwood, N. Y.)

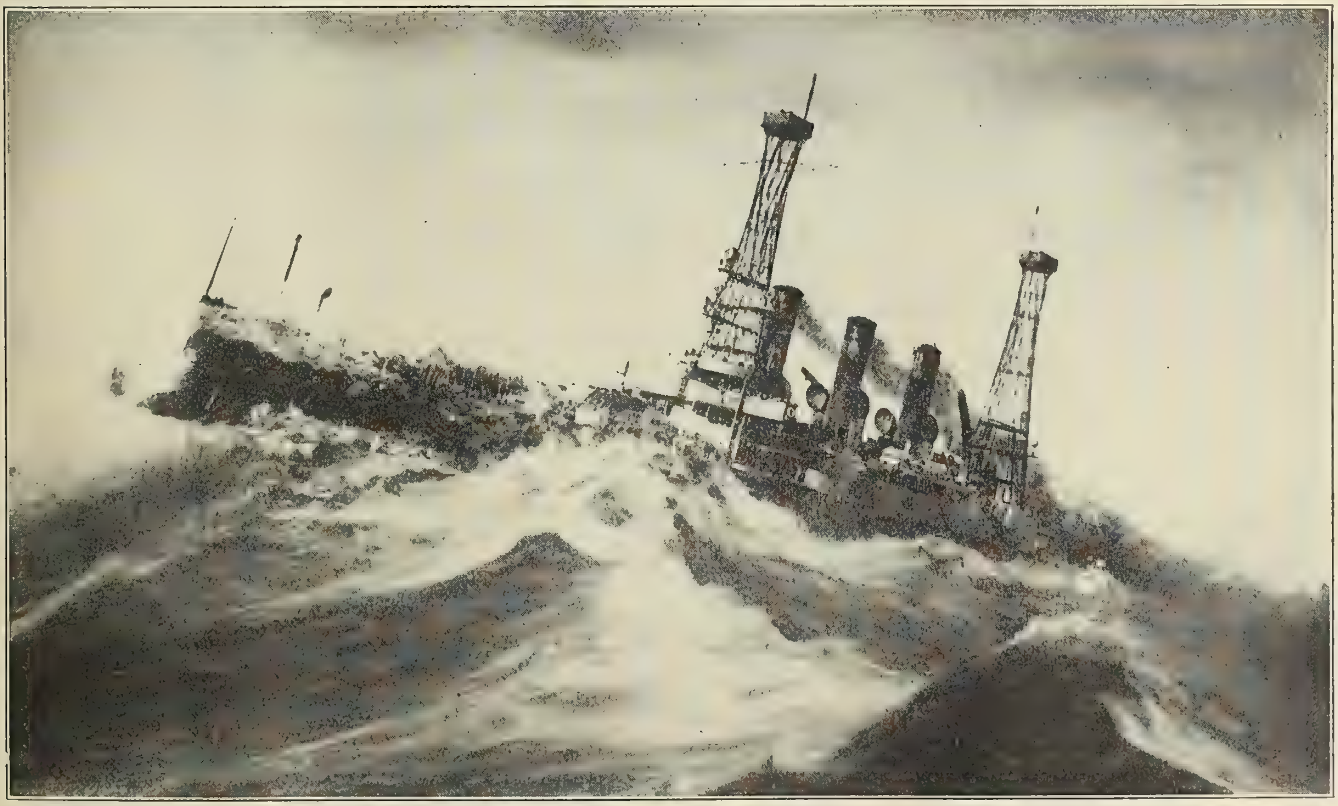
Fig. 2.—Clyde Liner *Carib* Coated with Ice after Regular Voyage to Boston

Fig. 3.—Futile Attempt of Packet Steamer to Break a Channel Through the Ice in Bear River, N. B.

(Copyright by Underwood & Underwood, N. Y.)

Fig. 4.—Italian Bark *Castagne* Ashore near Wellfleet

Institute of Marine Engineers.—The twenty-fifth annual meeting of the Institute of Marine Engineers was held in London, February 26. The present membership of the Institute is 1,408, a net increase of 58 during the year. The obituary list included the names of two past-presidents, the late Sir William White, K. C. B., and the late Sir David Gill, K. C. B. The following officers and members of the Council were elected for the coming year: President, Sir Archibald Denny, Bart, LL. D.; Hon. Treasurer, Mr. Alexander H. Mather; Hon. Secretary, Mr. James Adamson; members of council, Messrs. A. E. Battle, P. T. Campbell, B. P. Fielden, H. A. Ruck-Keene and W. T. Seaton.



(Photograph by Underwood & Underwood, N. Y.)

Fig. 5.—U. S. Battleship *Vermont*, with Decks Awash, Fighting a Winter Gale on Homeward Voyage from the Mediterranean

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

An Old Story in New Words

This short account of the cause of an entirely preventable accident, which caused the death of one man, is simply an old story set to new words. It is written simply in the hope that it may call attention to the urgent necessity for casualty drills in the fireroom.

In order to give an intelligent idea of existing conditions, it will be necessary to describe briefly the fireroom installation.

The fireroom contained one watertube boiler, one auxiliary feed pump and one large blower. The boiler was fitted with two gage glasses, Scotch type, each having a self-closing ball valve at the lower end, so arranged that when the draincock was opened the lower connection would be automatically closed, thus allowing the glass to be blown through. After the drain cock was used it was always necessary to unseat this ball, by means of the lower gage glass cock, before normal communication between the boiler and the glass could be restored.

In order to safeguard the men on watch, in the case of blowing tubes, a large ashpit escape was led from the back of the ashpit to a self-opening hatch on deck. This spring hatch, practically airtight when closed, was released by means of a toggle hanging directly over the head of the water tender on watch. It is quite easy to see that, with an air pressure equal to four or five inches of water, all escaping steam, from an ordinary rupture, could be easily taken care of by simply opening the ashpit escape and speeding up the blower. The hatch furnishing access to the fireroom was almost directly over the head of the water tender on watch.

One night last fall, while the vessel was steaming at about 18 knots, the hand on the engine-room steam gage commenced waving rather wildly, thus furnishing a pretty good indication that something was wrong. A messenger was immediately sent to the fireroom to inquire about the condition of the water in the boiler. The water tender had hardly finished assuring him that everything was all right when three tubes blew out with great violence, instantly filling the fireroom with steam.

A moment later the deck hatch was opened from below and the water tender crawled out, surrounded by a cloud of steam. Those on deck immediately slammed the hatch shut, and, running forward, opened the ashpit escape. In a very few minutes the blower had so cleared the fireroom that it was possible to go below, haul fires and investigate.

The fireman was found in the fireroom, entirely uninjured, but the water tender was so badly scalded that he died shortly afterwards.

A careful investigation established the following facts: The water tender, having acquired the habit of using only one gage glass, was following out his usual practice. Seeing that the gage glass needed blowing, he blew it through, closed the drain cock and then forgot to unseat the automatic ball valve, thus leaving the lower connection to the boiler closed. His attention was probably distracted for a sufficient time so that when he looked again enough water had accumulated by condensation, etc., to show in the glass.

The water shown, however, was not in communication with the water in the boiler, so the indication shown was entirely false. The water had continued to get lower in the boiler until the gage in the engine-room began to show signs of trouble. The arrival of the messenger excited the suspicions of the water tender, so that he immediately tried the trycocks. Of course, he did not get water in the trycocks.

The water tender then made that old and ever-recurring mistake which has been the cause of so many fatal accidents. He took a chance—exactly the same chance that most water tenders will take under similar circumstances—and started the auxiliary feed pump full speed. He did not believe that the water was very low. He thought—just as we always think under similar conditions—that the water was just below the glass and that a few strokes of the pump would bring it in sight. But this time it didn't do as expected. The water was too low for recovery, so three tubes blew out, flooding the fireroom with steam.

In the excitment of the escaping steam, the water tender forgot the ashpit escape and attempted to make his own way out of the fireroom by means of the regular deck hatch. While he was getting out, the air pressure drove the steam out in clouds around him, burning him so badly that his case was hopeless.

The fireman did not leave the fireroom. He simply stood in front of the blower until the fireroom was well clear of steam.

The water tender in this case was a tried and competent man. He first got into trouble by neglecting small things, and, when the trouble arrived, things happened so quickly that he lost his head. Thus, he lost his life through an accident that was entirely preventable and which, having arrived, could have been handled with comparative safety by the apparatus installed.

It seems to me that this should further impress upon all engineers the great necessity for having casualty drills among the fireroom forces. It is very difficult to make men enter into such drills with spirit, since each believes that he will be fully able to meet any emergency that might arise. Ordinarily, men look upon such drills as entirely unnecessary, and, at best, they look upon them as necessary evils, to be endured simply because they cannot prevent them. However, regardless of this feeling, men should be so drilled that they will automatically do the right thing in case of the more common accidents.

When a man for whose training you are responsible is killed by some entirely preventable accident, you will wonder if you are not slightly responsible for his death. This will be especially the case if you have not carefully prepared him to meet the emergencies of his necessarily dangerous calling.

W. W. B.

Follower Bolt and Cylinder Cover

After the steamer *H*——— had proceeded about 8 miles from her dock a heavy pound was heard in the high-pressure cylinder on the top center. With the first report the upper engine room became filled with steam, and it began to rain cast iron and asbestos. The engines were stopped, and at a glance the false cover of the high-pressure cylinder was seen lying on the intermediate-pressure receiver, all of the asbestos having blown out of the cover. As the vessel was in a dangerous part of the channel it was necessary to start the engines and work the ship to an anchorage. This was done at reduced speed, and at every revolution the heavy pound could be heard, accompanied by a rush of steam into the engine room.

On coming to anchor the cover was lifted, disclosing the fact that one follower bolt was missing. Upon examining the under side of the cover the bolt was found embedded in it, projecting the exact clearance. The cover was turned over and the bolt knocked out of the hole. It had broken at the bottom of the last thread, and was found to be of steel. The exact form of the bolt had been punched in the cover without fracture.

The hole was measured, and it was found that if it were made round a 2½-inch pipe tap would clean up a good thread. As there was a tap in the tool room and plenty of plugs on hand, the hole was chipped and filed round, tapped out, a well-leaded plug screwed home and the square cut off.

In the meantime the end of the old bolt was backed out of the piston and a new one inserted. The piston was measured on four points to determine if the rod had been sprung, which was found to be true. The cover was replaced and the engines started with 130 pounds of steam at reduced speed. As the repair proved tight the pressure was increased to the normal of 160 pounds and full speed resumed.

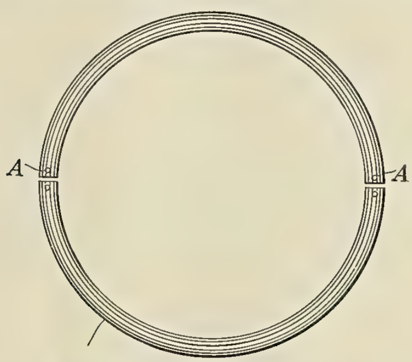
On arrival at the port of destination the plug was cut out and a solid cast iron plug, turned and threaded in the lathe, was screwed in with a ⅜-inch brass stopper pin tapped in one side. New follower bolts of Norway iron were also fitted. This engine with the repairs as described is still running on the coast. Engineer.

New York.

Wire Rings for Leaky Stuffing Boxes

Many engineers find it impossible to prevent steam and water from blowing by the piston rod and valve stems of an engine, due to the fact that the rods become worn and give too much clearance space around the rod in the bottom of the stuffing box, and also at the bore of the packing gland. The result is that the packing will work into the cylinder or by the packing gland.

To close up this clearance many engineers make, or have made, a ring of babbit or brass to fit the bottom of the stuffing box next to the packing gland. The writer has found that these rings take up too much space in the stuffing box, so that it is impossible to get a sufficient number of packing rings in the stuffing box to make a tight job; but if a ring made of No. 5 or 6 B & S gage copper wire is worked out to a good fit around the rod, this ring does not take up nearly as much space as a ring of babbit or brass.



Copper Wire Gage B and S 5 or 6 Size

Wire Ring Made in Two Parts

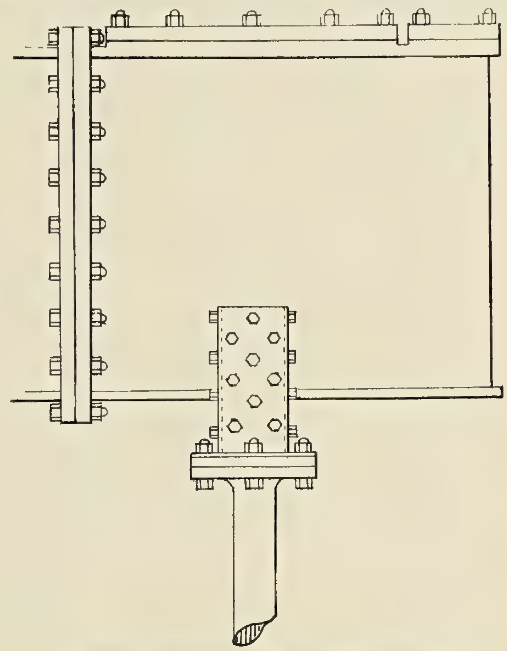
These rings are made in halves, as shown in the illustration. A small hole is drilled in each half of the ring, as shown at *A, A*. This is to keep the ring in place; while the packing is being placed in the stuffing box, the two halves of the ring are fastened together with small wires. After placing them around the rod, the wire ring is taken up by filing away at the two joints. The writer has had a set of these rings in use for the last two years and finds that they work satisfactorily in every respect.

There is another point about this arrangement which is important. When the rings are made in two parts they are kept in shape when placing them over the rod, whereas when the ring is made with only a single joint it has to be sprung over the rod and will not make a tight fit around the rod on account of its being pulled out of shape. H. A. Jahnke.

Milwaukee, Wis.

Repairing a Cracked Cylinder

While a ship of the Red Star line was proceeding down the English Channel, bound from Antwerp to Philadelphia, both legs of the high-pressure cylinder were discovered to be cracked just above the flanges where bolted to the columns. A heavy I-beam crosses the steam chest about two feet above it, and a hydraulic jack was placed between the top of the chest and the underside of this beam. When the jack was set up the cylinder was securely held, but the chief engineer decided that it would be unwise to attempt to cross the Atlantic with a passenger list of between 700 and 800 depending on this temporary arrangement.



Position of Patches on Cracked Cylinder

After consultation with the captain it was decided to put into Falmouth. On arrival there the superintendent engineer at Antwerp was notified by telegraph, and on his arrival at Falmouth a gang of men from a local machine shop was secured to work under his direct supervision.

Lead templates, covering the legs of the cylinder and extending out over the flanges on same, were made, and from these templates patches were made of ¾-inch steel boiler plate. Holes for ¾-inch bolts, snug-fitted, were drilled in these patches after they had been carefully fitted in place, together with holes for the bolts that fastened the legs to the columns. Corresponding holes were drilled in the legs in front and on the sides for a ¾-inch tap, and when the patches were fastened in place, as shown in the sketch, the cylinder was as securely held as it was originally.

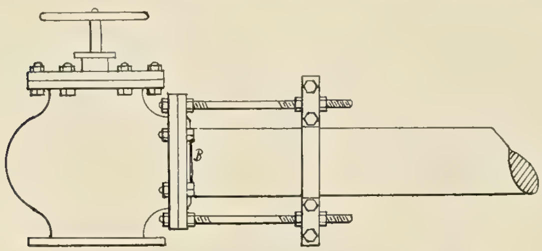
On arrival in Philadelphia the question of replacing the cylinder was discussed, but it was finally decided to let well enough alone and the cylinder was not replaced for several years, when a crack developed in the steam jacket. During this time not the slightest trouble was experienced with these patches. J. S.

A Cracked Steam Pipe

While closing the main stop valves on the boilers in an ocean-going tugboat on arrival at the dock for orders, the main steam pipe was found cracked close to the flange, as shown at *B* in the sketch, the crack extending about one-third way around the pipe.

Orders were received to proceed immediately with a light tow to the home port, and the chief engineer decided that this could be done without very much delay. There were no facilities for repairing the damaged pipe in the place and it would mean a delay of several days to send the pipe away to have it repaired, this being the important factor that caused him to arrive at this decision.

Unlike an ocean liner, these tugboats do not carry a very large stock of repair material, and it required some ingenuity to obtain what was needed, but a marine engineer is seldom balked in an emergency.



Device for Strengthening a Cracked Steam Pipe

The bands around the tops of a couple of ash buckets, made of ⅝-inch by 2-inch iron, were cut off and forged in the fireroom into a clamp, as shown at *A* in the sketch. While this was being done, a tube rod of ¾-inch round iron was secured and long studs made from it, as shown in sketch, the covering on the pipe meanwhile being removed.

When the clamp was made, the holes drilled in it and bolts procured, it was secured in place, as shown. Thimbles made out of pipe were placed between the halves of the clamp over the bolts, so that when the inner bolts were tightened the clamp compressed the pipe, thus obtaining a secure grip on it. Two opposite bolts were then removed from the flange and the long studs inserted in their places, and then the nuts on the other ends of the studs tightened until there was as much strain on the studs and clamp as could be safely borne.

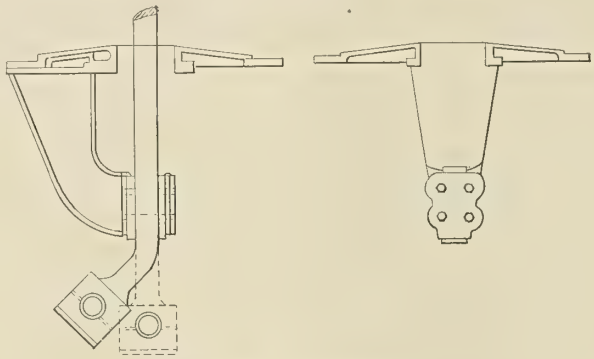
When this was done, all was as shown in the sketch and the chief engineer felt confident that, even if the crack extended, which he did not believe it would do, the pipe would not tear away from the flange. His confidence in the job was not misplaced, as was evidenced by the fact that on arrival at the home port the crack had not extended at all, and he was complimented by the shore engineer for bringing the boat home with such little delay, two hours being the entire time consumed in getting the gear ready and putting it in place. M. A. Penfield.

A Very Unusual Accident

A ship had made all the usual preparations for getting under way; her engines had been warmed up and everything in the engine room made ready to turn over the engines. The links were amidships, and the engineer moved the reversing lever in the go-ahead position. The reversing engine moved, but instead of the link blocks moving out in the radial link and the valves moving off the center position, uncovering the ports to admit steam into the cylinders, the high-pressure link block stuck fast in the link; and the reversing engine, continuing to move, bent the valve stem guide bracket and eccentric rods of the high-pressure engine. The ship went out of port with one engine in operation and work commenced on the disabled engine.

The high-pressure valve was examined and found to work freely and to be free of anything that would make it stick. So the accident was not caused by the valve being frozen, as the saying is.

One of the theories advanced to account for the trouble was that the pressure in the valve chest was not equalized and was so much greater on one side of the valve that it resisted the force exerted by the reversing engine to move the valve. While this was an ingenious theory and a probable one, nevertheless, to the writer's mind, the cause of the accident was due to the link block sticking and straining the valve stem out of line; and as the force continued, the valve stem guide and eccentric rods were badly bent.



Bent Valve Stem

It was impossible, with the facilities at hand, to straighten the valve stem bracket, which was of cast steel, so a line was run through the bracket and measurements made as to the extent of the bend. The brass bushing in the guide was bored out large and babbitted, after which the bearing was bored to fit the stem, with such regard for the altered alinement of the planed surfaces of the bracket as to bring the hole in line with the valve stem. The valve stem, which was three inches in diameter, was bent about forty-five degrees, close up to the yoke end. In straightening it some bumps were caused, which were removed by turning down the stem to two and seven-eighth inches for a distance of about twelve inches. To straighten the eccentric rods was quite a simple matter.

After assembling, the engine was tried; and everything being found satisfactory, it was used with the other engine, enabling the vessel to reach the next port with little loss of time. The valve stem was used for more than two years before being renewed. J. E. C.

Be Certain that Steam is Entirely Shut Off Before Disconnecting the Engine.—A large steeple compound engine in a rolling mill was disconnected to make repairs to the crosshead brasses. Steam leaked by the throttle valve into the high-pressure cylinder. When sufficient pressure had accumulated to overcome the friction, the pistons moved, the expansive power of the steam increased the velocity and forced the pistons against the cylinder heads with such power that the high-pressure and low-pressure cylinder heads were broken and the engine wrecked. The intermediate-pressure engine of a vertical triple-expansion engine was disconnected, after being shut down, but before the steam was off the engine and the vacuum in the condenser destroyed, the piston was forced up the cylinder about half the stroke, then it fell back to the bottom of the cylinder, and though no damage resulted the workmen had a narrow escape from serious injury by the end of the connecting rod falling over on the frame of the engine when the piston rod rose. C.

Marine Articles in the Engineering Press

The New Shipbuilding and Engineering Works at Willington Quay.—The firm of Joseph T. Eltringham & Company, Ltd., shipbuilders, ship repairers and marine engineers, which was established at South Shields are far back as 1846, recently acquired an area of ground at Willington, Quay-on-Tyne, which many years ago was occupied for shipbuilding purposes by Palmers Shipbuilding & Iron Company, and thereon has erected one of the most completely-equipped shipyards for its size in England. The yard has a river frontage of 460 feet and is capable of dealing with vessels up to 325 feet in length. There are four shipbuilding berths, a fitting-out shop, joiner shop, blacksmith shop, engine shop, frame shed, power station and offices. At the west end of the yard space is reserved for the construction of a large graving dock. Early in its career, this firm acquired a world-wide reputation for the construction of tugs, trawlers and other small vessels. Of late years, however, they have made a specialty of high-class passenger steamers of moderate dimensions. The new yard was officially opened February 5. 4 illustrations. 1,100 words.—*The Shipbuilder,* March.

Japanese Institution of Naval Architects.—At the annual meeting of the Japanese Institution of Naval Architects, held November 14 to 17, the following papers were read: "On the Use of Special Steel in Warships," by Commander Y. Hiraga, Naval Constructor at Yokosuka; "On Some Experiments on Mild Steel and Special Steel Rivets," by Commander Hiraga and Lieutenant Hashiguchi; "On Recent Studies in Connection with Rivets, Riveting and Riveted Joints," by Lieutenant Y. Taji, Assistant Naval Constructor; "On Rolling and Anti-Rolling Tanks," by Dr. Suyehiro, Professor of Naval Architecture, Tokyo Imperial University; "On Watertube Boilers for Marine Purposes," by M. Miki, Engine Shop Manager of the Mitsu Bishi Works at Kobe; "On the Construction of Ships with Flanged Plates," by K. Ota, Surveyor to the Mercantile Marine Bureau, Department of Communications; "On the Preservation of Timber and On Bottom Painting," by Dr. T. Shiga; "On the National Flag and Its Use in Ships," by N. Matsunami; "On Vibrations of Ships and Instruments to Measure Them," also "On a Rollingless, Pitchingless and Waveless Ship," both by Dr. Y. Yokota, Professor of Naval Architecture, Tokyo Imperial University. A comprehensive account of the proceedings was contributed to this journal by Professor F. P. Purvis, of the Tokyo Imperial University, including abstracts of the President's address and of the most important papers. 9 illustrations. 4,500 words.—Engineering, *February* 6.

Three-Masted Schooner Aosta with Savoia Diesel Marine Engines.—The *Aosta* is a three-masted schooner 184 feet long, 28.2 feet beam and 14.3 feet depth, with a displacement of 1,050 tons and a deadweight capacity of 700 tons. There are three holds, each supplied by a steam winch, with the engineers' quarters and accommodation for four passengers in the poop deckhouse. The ship is fitted with a four-cylinder Diesel engine, manufactured by the Societa Anonima Cantieri Officine Savoia, Cornigliano, Liguire. The engine is of the two-stroke cycle type, with cylinders 13.75 inches diameter and 19.7 inches stroke, developing on 200 revolutions per minute about 440 brake horsepower, corresponding to the comparatively high mean effective pressure of about 127 pounds per square inch, assuming the engines to have a mechanical efficiency of about 73 percent. Besides the main oil engine, there is a donkey boiler for steam heating and for driving the auxiliary compressor and winches. The auxiliary compressor is driven by a steam engine of 25 horsepower. The four cylinders of the main engine are arranged in two sets of two each, with the scavenging pumps and compressors between the sets. The cranks of both the scavenging pumps and of the main engines are set at 90 degrees to each other, the advantage of this arrangement being the very good balance of rotating masses with a minimum degree of irregularity of running and the possibility of starting the main engine by allowing compressed air to act in the two double-acting scavenging pumps. The compressors are placed on top of the scavenging pumps. For actuating the valve gear, eccentrics and eccentric rods alone are used. Indicator diagrams taken from the engine when the ship was light, with the propeller only partly immersed, give a maximum pressure of 470 pounds per square inch, a mean effective pressure of 110 pounds per square inch, and an indicated horsepower of 520 for the four cylinders at 200 revolutions per minute. Assuming the mechanical efficiency of 73.2 percent attained at the shop trials, the brake horsepower works out at 380. 18 illustrations. 1,500 words.—*Engineering,* February 6.

The White Star Liner Britannic.—A very complete and fully illustrated description of the new White Star Liner *Britannic,* launched recently by Harland & Wolff, is given. The main particulars of the ship are: Length over all, about 900 feet; breadth, extreme, about 94 feet; depth, molded, 64 feet 3 inches; gross tonnage, about 50,000 tons; load draft, 34 feet 7 inches; displacement at load draft, over 53,000 tons; indicated horsepower for reciprocating engines for ahead and astern driving, 32,000; shaft, horsepower for low-pressure turbine for ahead drive, 18,000; service speed, 21 knots; number of decks, 9; passenger accommodations, first class, 790; second class, 836; third class, 953; total passengers, 2,579; crew, 950; total, 3,539. The article is divided into sections dealing with the construction of the hull, arranagement of the decks, electric installation, ventilation, sanitation, the general arrangement of the propelling machinery, the reciprocating engines, the exhaust turbine, maneuvering gear, condenser and boiler feed plant, boilers, pumping arrangements, refrigerating plant, applianaces for handling and working the ship, life boats and lowering gear, and the launch of the vessel. The boiler plant, which includes twenty-four double-ended and five single-ended boilers, is arranged in six boiler rooms. The boilers are all 15 feet 9 inches mean diameter, the double-ended boilers being 21 feet mean length and the single-ended boilers 11 feet 9 inches mean length. The heating surface of each double-ended boiler is 5,702 square feet and the grate area 130.8 square feet, while in the single-ended boilers the heating surface of each is 2,822 square feet and the grate area 65.4 square feet. The main reciprocating engines, which are of the four-cylinder, triple-expansion type,, with cylinders 54, 84, 97 and 97 inches diameter and 75 inches stroke, are located in one engine room with the usual feed, sanitary and bilge pumps and all auxiliaries associated with the boiler feed, the refrigerating machinery, and, on the lower deck level, a fully-equipped workshop. The exhaust turbine driving the center shaft is in a separate compartment, abaft the reciprocating engine room, exhausting into two condensers. The turbine is about 50 feet long and weighs complete 490 tons. It operates at full power at 170 revolutions per minute. The wing screws, driven by the reciprocating engines, are 23 feet 9 inches diameter, designed to run at 77 revolutions per minute, while the center propeller, which is four-bladed, is 16 feet 6 inches diameter. 81 illustrations. 15,000 words.—*Engineering,* February 27.

Marine Refrigeration and Insulation.—Although great diversity of opinion exists among ship owners as to the most suitable system of refrigeration, nevertheless the author of

this article maintains that for marine work the compression system is highly advantageous. Three principal types of the compression system are now in general use—the air, the ammonia, and carbon-anhydride systems. These three systems are described briefly, after which the subject of insulation is taken up in more detail. It is pointed out that no mater how efficient the refrigerating machinery may be the ultimate economy of the plant greatly depends upon the quality and nature of the medium used for insulation. By practical tests and long experience, as well as theory, it has been found that those substances possessed of minute air cells offer the highest resistance to the passage of heat energy and are the most perfect insulators. In the opinion of the writer, the best results are obtainable from a combination of wood and granulated cork; cork, being impervious to heat, capable of withstanding moisture, very light (one cubic foot weighs about 7 to 8 pounds packed) and easily handled. Another insulating material which has been adopted in steamers built in the United States is the waterproof lith board made by the Union Fiber Company, of Winona, Minn., from a combination of flax fibers and mineral wool. It is claimed that this substance has been proved by reliable tests to be 7.25 percent more efficient than cork board, but the writer has had no experience with lith board. Discussing further the subject of insulation, the thickness of insulating material and the methods of application of the insulating material, are taken up in detail. An important point is brought out, namely, that since it is impossible to examine continually the steel work behind the insulation, it is of the utmost importance that all steel work should be riveted perfectly tight and watertightness insured before the insulation work is commenced. Much damage may be caused to a valuable cargo by leaky rivets and bolts in watertight decks, etc. After giving some brief notes regarding the refrigerating machinery on the Cunard Liner *Mauretania,* and on the White Star Liners *Olympic* and *Ceramic,* a very thorough description is given of a typical modern refrigerated steamer, the vessel chosen being *El Uruguayo,* one of five fine twin screw steamers recently completed for the fortnightly express service between the river Plate and London, and owned by the British & Argentine Steam Navigation Company and Messrs. Houlder Brothers & Company. These vessels were built to the plans and specifications of Messrs. William Esplen Son & Swainston, Liverpool, and each has a total insulated capacity of about 400,000 cubic feet, ranking among the largest meat carriers yet constructed. The vessels are 440 feet long between perpendiculars; 58 feet 8 inches beam, molded; 38 feet depth, molded to shelter deck; 8,360 gross tons; 4,693 net tons; with a deadweight capacity on a 27-foot 6-inch draft of 8,300 tons. On a load draft the vessel has a displacement of about 15,000 tons, and provision is made for 12 first class passengers and 350 emigrants. Four decks extend over the full length of the ship, and seven steel transverse bulkheads extend to the shelter deck, besides which there are three bunker screen bulkheads. All five holds as well as the 'tween decks are completely insulated for the cargo of chilled and frozen meat, granulated cork being employed throughout the cargo holds, except for the machinery bulkheads, where silicate cotton is used for insulation. The refrigerating machinery is of the standard duplex marine type, supplied by Messrs. J. & E. Hall. The vessel is propelled by two sets of triple expansion engines at a service speed of 15 knots, steam being supplied by 6 single-ended boilers working under Howden's forced draft system. 23 illustrations. 4,000 words.—*The Shipbuilder*, March.

The New Harbor Works and Dockyard at Gibraltar.—By Adam Scott. This paper gives a general description of the comprehensive project which has been carried out for the inclosure and defense of the harbor and the extension of the dockyard at Gibraltar. This scheme included an extension of the south mole by 2,700 feet, the construction of a detached breakwater 2,720 feet in length, a large northern mole with coaling jetties, the extension of the naval yard, including the construction of three large graving docks, wharf walls, slipways, pump house, workshops, storehouses, officers' rooms, etc., and the deepening of the harbor.—A paper read before the *Institution of Civil Engineers,* February.

Corrosion of Iron and Steel Structures and Their Preservation.—By F. Crosby-Jones. The object of this paper is to seek out the best means of abating the inroads of corrosion on iron and steel. The author concludes that all structures should be composed of the same metal as far as other constructions will allow; surfaces should be even and free from depressions, cracks and curves, wherein water can lodge; pockets that allow of the collection of water should be avoided; all members should have free air circulation around them; provision should be made where necessary for the drainage of water; joints, rivet heads, bolts and nuts should be given special attention to insure exclusion of water and all parts that are not easily visible should have careful inspection. When painting has to be done, it is advisable that each coat should be of a different shade, in order to facilitate inspection and to check the number of coats used. Above all, before a protective coating is applied, the metal must be cleaned and dried, then a good material used and the work must be properly carried out. 6,250 words.—Paper read before the *Institute of Marine Engineers,* January.

Some Experiments on the Condensation of Steam.—By Gordon C. Webster. This paper describes a series of experiments made by the author during his tenure of a post-graduate research scholarship in the Mechanical Engineering Department of the Royal Technical College, Glasgow, to determine the rate of condensation of steam upon a metal surface, with special reference to the influence of the velocity and density of the steam. The data obtained from these experiments are presented in the form of tables and curves, from which the following points are brought out: For a given temperature difference between steam and the metal the condensation rate varies with the speed of the steam. For steam at constant pressure and velocity, the condensation varies as the difference in temperature between the steam and the metal. The effect of the steam pressure and velocity, however, cannot be neglected. The curves readily show the effect of velocity upon condensation, and also the effect of density upon condensation, both of which, contrary to conclusions arrived at by the previous investigators, must be taken into account. 12 illustrations. 6,000 words.—*Transactions of the Institution of Engineers and Shipbuilders of Scotland,* December.

Observations on Ocean Temperatures in the Vicinity of Icebergs and in Other Parts of the Ocean.—By C. W. Waidner, H. C. Dickinson and J. J. Crowe. The records of sea water temperatures obtained by means of an electrical resistance thermometer and a Leeds and Northrup temperature recorder installed on the U. S. S. *Chester* and *Birmingham* in their patrol of the North Atlantic ocean in June and July, 1912, show that the temperature variations in parts of the ocean far removed from ice are often as great and sudden as in the neighborhood of icebergs. So far as the records obtained are concerned, the authors conclude that it does not seem possible to draw positive conclusions as to the absence or proximity of ice from the temperature records of sea-water. On the other hand, the temperature record may give valuable information on the approach to shore or shallow water, on the identification of characteristic ocean currents, and even of the proximity of icebergs in some parts of the ocean where the variations are less erratic than in the regions in which the authors' observations were made. Further investigations are desirable before final conclusions are drawn. 16 illustrations. 5,200 words.—*United States Naval Institute Proceedings,* December.

New Books for the Marine Engineer's Library

The Diesel Myth. By F. Lueders. Size, 6½ by 10 inches. Pages, 236. Illustrations, 12. Berlin W., 1913: M. Krayn. Price, $1.15, paper covered.

The author makes a startling attack upon Dr. Rudolf Diesel, the originator of the modern high-pressure oil engines. He attempts to prove from Diesel's writings that the modern so-called Diesel engine was not invented, but was evolved more by accident during the unsuccessful attempts of producing the rational heat motor of the original patents. The author tries to show that the fundamental assumptions and theories of Diesel were incorrect or impracticable, and that for this reason an uncooled cylinder with a perfect Carnot cycle could never succeed, to say nothing of the fact that the cylinder and engine dimensions would have been prohibitively large to secure the necessary air surplus. Dr. Diesel is considered guilty of a shifting opportunism, which hid failures and readily advanced new facts that promised glory and reputation. The book freely acknowledges the inestimable value of the so-called Diesel engine, but considers Dr. Diesel as the purely accidental cause of its production.

It is almost to be regretted that so much careful labor in the arrangement of documentary material should have been directed to a negative purpose.

A Year With a Whaler. By Walter Noble Burns. Size, 5½ by 8¼ inches. New York, 1913: Outing Publishing Company. Price, $2.00.

Mr. Burns has written an unusually readable book. It gives a phase of life on board a whaler that is seldom written up. As Mr. Burns shipped as a green hand, he naturally writes from the point of view of whaling as seen by the men in the forecastle. It is a true picture of life on a whale ship, quite different from a story published some years ago by Mr. Bullins, entitled, "The Voyage of the Cachelot." Mr. Bullins' story did not sound true; and as the writer of this review was in the Arctic Ocean years ago, he knows that it was not true and that Mr. Bullins' picture was overdrawn to produce picturesque effects. On the other hand, Mr. Burns presents his side of the story in a straightforward manner, and his book is a valuable contribution to literature regarding this industry, which is gradually becoming extinct. He makes considerable of the desire of sailors to run away, apparently not appreciating that it is an inborn trait of all sailors to want to run away as a matter of habit. He does not appreciate the difficulties under which the men in the cabin labor with an irresponsible crew, for all sailors are irresponsible. At the same time he is to be congratulated upon writing such a good story.

Computations for Marine Engines. By Professor C. H. Peabody. Size, 6 by 9 inches. Pages, 206. Illustrations, 51. New York, 1913: John Wiley & Sons, Inc. Price, $2.50 net. London, W. C., 1913: Chapman & Hall, Ld. 10/6 net.

For many years instruction in marine engine design at the Massachusetts Institute of Technology, under Professor Peabody, was carried out with the aid of loose leaf notes which the students invariably had bound in such form as suited their needs for future reference. The appearance of this book will, therefore, be gladly welcomed not only by the students at the Institute, but also by other men engaged in marine engine work. As the book is arranged to meet specifically the special needs of the method of instruction adopted at the Institute, where complete designs of actual marine engines are available for comparison and study by the students, and where the student's work in marine engine design is controlled by giving him the data and proportions he is incapable at first of selecting for himself, no attempt has been made to present in the book more than the methods of computing the proper size and strength of the parts of a marine engine similar to those in good practice. To other students and engineers who do not have detailed drawings and data from actual designs at hand, it might be pointed out that such material is continually appearing in the engineering press and can be easily obtained. The chapters in the book are as follows: Preliminary Computations, Indicator Diagrams, Forces and Rotative Effects, Computation of Strength, Balancing Engines and Internal Combustion Engines.

The Engineering Index Annual for 1913. Size, 6½ by 9¼ inches. Pages, 510. New York, 1914: The Engineering Magazine Company. Price, $2.00.

The publishers of The Engineering Index Annual are to be congratulated upon their promptness in issuing the volume for 1913. The book was on the market within six weeks of the close of the calendar year, a service that will be greatly appreciated by the users of such an index. As has been the case in previous years, the book comprises a complete index of all articles published in the engineering press during the year, so classified and cross-indexed that a few moment's search will inform the specialist of the number, length and nature of all articles that have been published during the year on any engineering subject. Furthermore, the publishers of the index are in a position to supply at short notice and at a minimum cost copies of any of the articles indexed, if not out of print. The value of this book is obvious, and a copy of it should be in the library of every engineer.

"Verbal" Notes and Sketches for Marine Engineers. Eighth Edition. By J. W. M. Sothern. Size, 6 by 9 inches. Pages, 676. Illustrations, 545. Glasgow, 1913: James Monro & Company, Ltd. Price, 12s. net.

In order to bring this well-known manual of marine engineering practice thoroughly up to date, the author has added a new appendix covering the subjects of internal combustion engines, Diesel engines, steam turbines and boilers. A number of new drawings, notes and calculations referring chiefly to Diesel oil engines, boilers and marine turbines, have been introduced, the latter including exhaust turbines and geared-down turbines. It may be recalled that when the seventh edition of this book appeared in 1911 the book was practically rewritten and re-illustrated. The book is intended for the use of naval and mercantile marine engineers of all grades, students, foremen, engineers, etc., and is specially compiled for the use of engineers preparing for examinations of competency at home and abroad. The book contains a vast amount of practical information, the value of which is greatly enhanced by the use of carefully-prepared sketches and drawings, many of which are reproduced to a large scale in the form of plates. Every marine engineer should have a copy of this book and make free use of it.

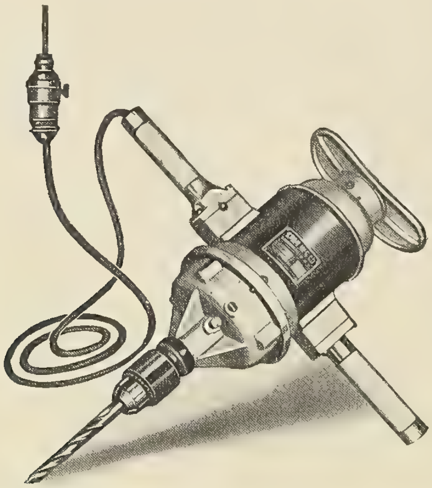
Great Lakes Register. Size, 12 by 8¼ inches. Pages, over 600. Cleveland, Ohio, 1914: Great Lakes Register.

The rules and tables for the construction and classification of steel, iron and wooden vessels navigating the Great Lakes now have the approval and endorsement of Bureau Veritas, of France. The existing alliance of Bureau Veritas with Great Lakes Register enables the committee to issue certificates of classification for over-sea navigation to Lake-built vessels, and the value of the Great Lakes Register Rules and Tables in connection with the shipbuilding and commerce of the Great Lakes is thereby greatly enhanced. The greater part of the Register is composed of classified lists of the steam vessels and sailing vessels on the Great Lakes. The hull and machinery data for the vessels are tabulated in convenient form, and a system of symbols and abbreviations is used to indicate the construction features.

ENGINEERING SPECIALTIES

New Type ½-Inch Electric Breast Drill

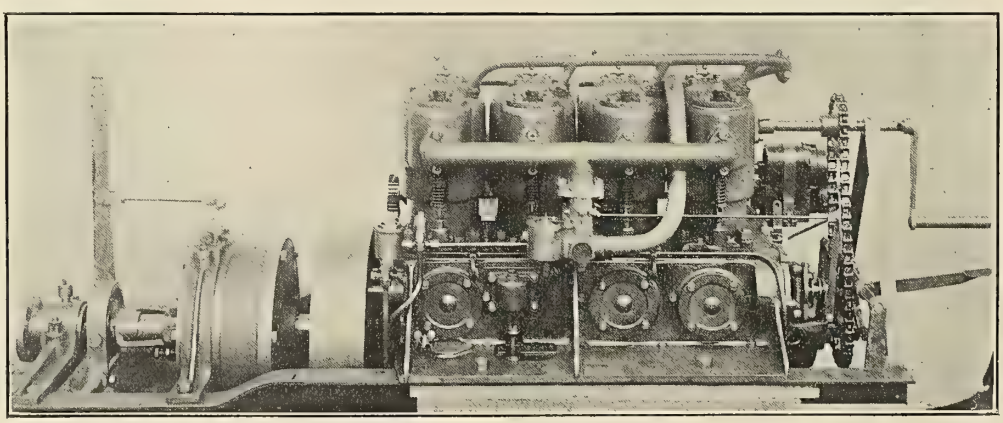
The Stow Manufacturing Company, Binghamton, N. Y., has on the market a new type of electric breast drill with a capacity for ½-inch holes in iron or steel and ¾-inch holes in hard wood with Jennings bit. The drill is furnished in two types, one for alternating current of 100 or 220 volts,



60 cycles, and the other for direct current of 120 or 220 volts. The first machine is 5¾ inches diameter, 13 inches high without the chuck and weighs 22 pounds. The other machine is of the same diameter, but has a height of 13½ inches without the chuck and weighs only 20 pounds. The manufacturers claim that these weights are as light as it is practicable to use with this size of drill. All parts of the drill are equally balanced, making it an easy tool to handle. The reduction gears are so designed that power is transmitted equally from the opposite points on each gear.

Brooke Motor Exhibit at Olympia

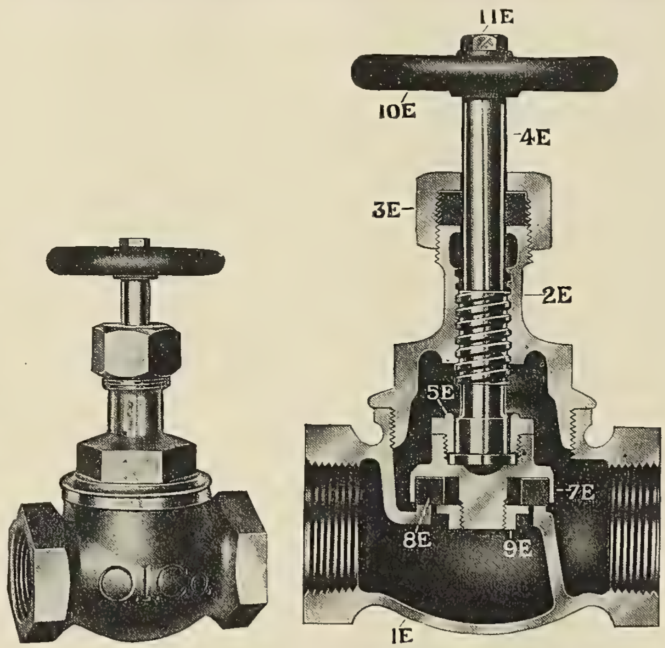
Since previous marine motor exhibitions were held many alterations have been made in the details of construction of the motors manufactured by J. W. Brooke & Company, Ltd., Adrian Works, Lowestoft. These alterations, however, relate chiefly to the accessory gear. At the Olympia-Aero and Motor Boat Exhibition, held in March, this firm exhibited sixteen of



its motors, ranging in size from 3 to 120 horsepower. In addition there was a 33-foot Brooke racing hydroplane engined with a 270-horsepower, 8-cylinder, V-type Brooke motor capable of a mean speed of 41.8 knots, and also a 20-foot launch equipped with a 4-horsepower, single-cylinder, Brooke motor. Another feature of the exhibit was a 15-horsepower, single-cylinder, two-stroke, Brooke semi-Diesel motor. The actual power developed by this motor is 21 at 480 revolutions per minute. It is designed essentially for using the crude oils having a specific gravity of about .86. The fuel consumption is guaranteed not to exceed .55-pound per horsepower per hour. The semi-Diesel motor is non-reversible, but is equipped with a reversing gear of the epicyclic type. A very important feature with all the Brooke motors above 18 horsepower is the fact that the injection pipes are now jacketed and the lubricating oil is passed through these jackets, which thus perform the double operation of warming the incoming gases and keeping the lubricating oil cool. Brooke-Zenith carburetors are fitted to all Brooke motors except the 3 and 4-horsepower types.

The "O. I. Co." Composition Disk Valve

The composition disk valve manufactured by the Ohio Injector Company, Wadsworth, Ohio, is made of a high grade of steam metal, all parts being made to gage in order to insure



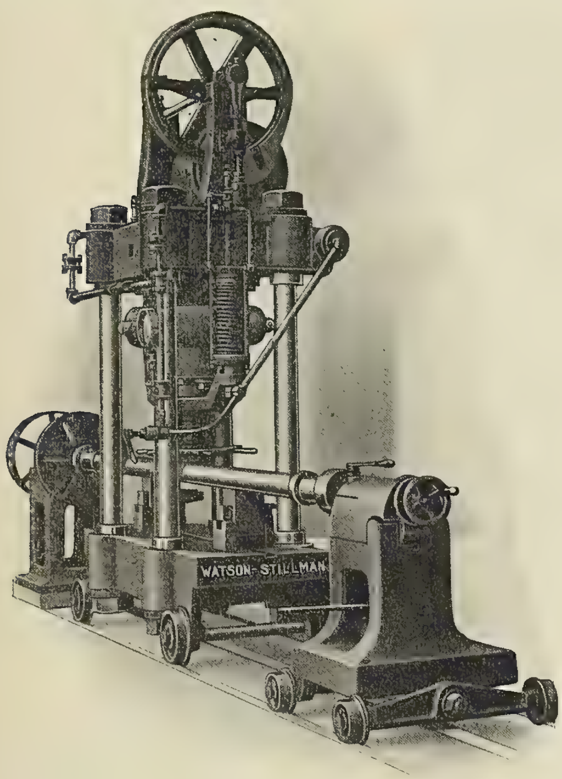
perfect fits in pipe threads and interchangeability of parts. The composition disk is made of a special compound especially adapted for use under severe service of all kinds. It is claimed that the composition disk will not break, crack or become brittle and pit. The disk wears down to a thin ring, thus giving an exceptionally long service, with the advantage over re-grinding or metal disk valves that it costs much less to renew a disk than it does to regrind a valve. The valves are designed for working pressures up to 200 pounds per square inch and have been approved by the United States

Steamboat Inspection Service. The packing for the spindles consists of a special molded split ring which fits the stuffing box and spindle accurately and requires very little compression to make a steam-tight joint. This ring is composed of braided asbestos thoroughly lubricated and coated with graphite to prevent friction and wear on the stems. The areas in the valves are far in excess of the pipe areas.

Hydraulic Shaft Straightener

The Watson-Stillman Co., New York, has recently produced an hydraulic press that has a capacity of 325 tons, which is sufficient for taking the bends out of any steel shaft up to 10 inches diameter, the length being limited only by the extent of the foundation provided.

As shown in the illustration, it is a motor-driven, self-contained unit, requiring no outside air or hydraulic system. There are three independent parts: the head stock, which is



stationary, and the press and tail stock, which are on rollers to permit their adjustment to varying lengths of shafts. The bed rails are flush with the floor, so that when not in use the movable parts can be rolled to one side, leaving the floor clear of obstructions. The head and tail stock are similar to those of a lathe, except that the centers are hinged to follow the movement of the shaft ends when the bend is made.

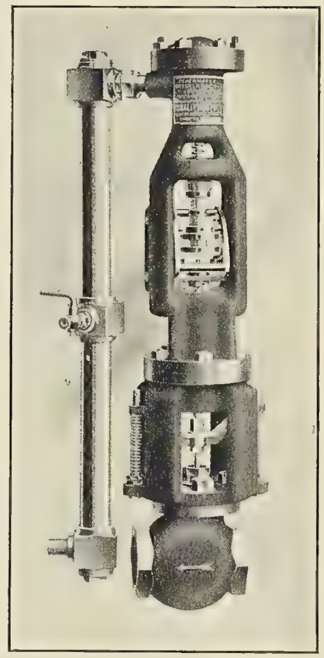
The shaft is revolved from the head stock and the "high point" marked. The press is then moved to that point and the bending blocks adjusted. The ram has a maximum movement of two inches and screwed concentrically into it is a square-threaded adjustment screw, which compensates for the different diameters of the shafts, and also enables the operator to predetermine the flexure desired. This, it is claimed, positively eliminates all danger of overbending.

The entire hydraulic power plant, including a 5-horsepower motor, pump, reservoir, etc., is mounted on the top platen of the press. The floor space required is 3 feet 6 inches wide by the length of the shaft, plus 6 feet. The total net weight of the press is 19,300 pounds.

"Thermofeed" Differential Pump Governor

The "Thermofeed" differential governor, which is manufactured by Ronald, Trist & Company, Ltd., 4 Lloyds avenue, London, E. C., is a device which shuts off the supply of steam to any class of steam or power-driven pump whenever the pressure becomes excessive, the excess sufficient to stop the pump being anything from 3 pounds per square inch upwards. The device aso admits a supply of steam to the pump by opening a double-beat throttle valve when any predetermined lower pressure is attained. A closed cylinder fitted with a piston which is fitted with a rod extension receives the main water pressure from the feed line on its upper side, while on its lower side is fitted a spiral steel spring. In this way the pressure on the feed line is converted into mechanical movement which is utilized to operate the control mechanism.

A downward movement of the main piston and its rod with its movable head pieces depresses a spindle to which is fitted the "thermofeed" double valve. This permits steam entering into a small cylinder, which, in turn, by means of a piston



directly over the rod or spindle and the double-beat throttle valve, closes the latter. One of the circular plates or head pieces on the upper or power cylinder will, on a drop in the pressure of the feed line and on its upward journey, engage with a pair of projections attached to a curved trigger piece. This trigger piece, having previously held the control valve in its down position until the upward pull on the projections permits it to trip, causes the small cylinder to exhaust to the atmosphere and thus readmits steam to the pump.

The control spindle, to which the control valve is attached, has a central poppet piece working in conjunction with a spring. The object of this is to prevent injury to the valve mechanism from any violent blow which might be given by the upper piston through erratic movement of the pump, such a blow being taken by two projections cast on the frame.

The Fulton (Diesel Type) Oil Engine

The Fulton-Diesel oil engines are of the high-speed, heavy-duty, single-acting, four-cycle type with fully-inclosed crank case, constructed to use crude oils, residues or ordinary kerosene (paraffin) for fuel. Three sizes are on the market for marine use, a 3-cylinder 50-horsepower engine, a 4-cylinder 70-horsepower engine, and a 6-cylinder 100-horsepower engine. The cylinders are all close ground cast iron, cast separately with large spaces for cooling water. The cylinder heads are

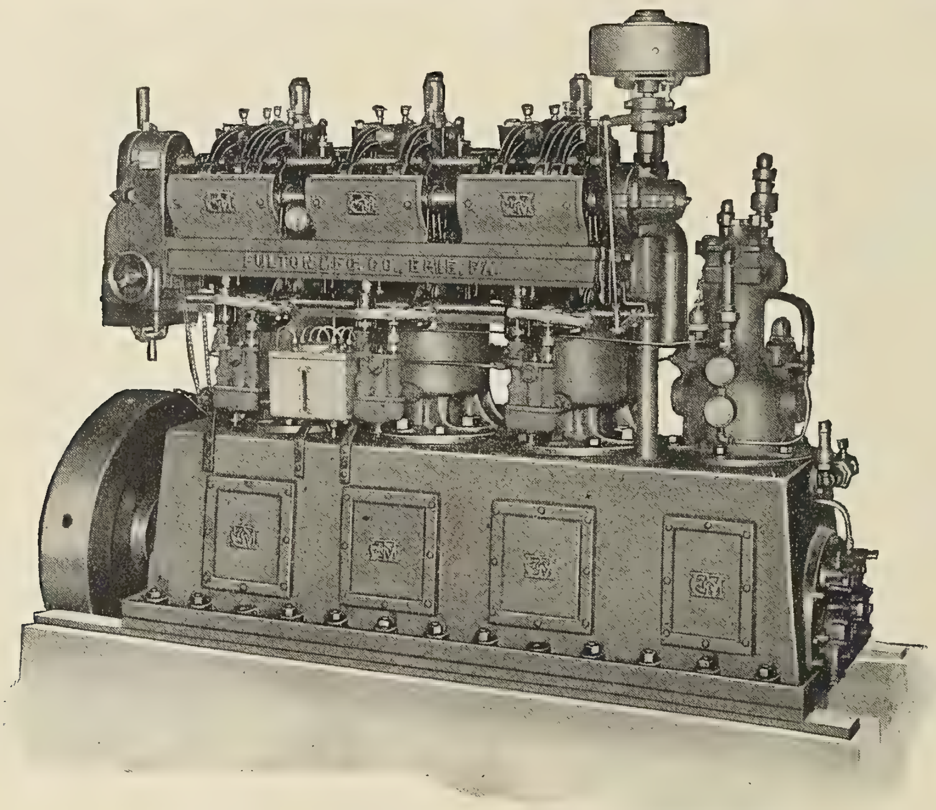
of a special grade of cast iron carefully designed with a view to overcoming undue strains. The pistons are of cast iron of the trunk type, fitted with hammered cast iron rings carefully fitted into grooves. Six rings are assembled above the wrist pin to insure uniform compression and two scraper rings are at the bottom to prevent an excessive amount of lubricating oil from reaching the compression chamber. The crank case is of the fully inclosed type bolted to the engine bed on the center line of the crank shaft. Rods of special high-grade hammered steel tie the cylinders directly to the engine bed, thus removing from the crank case the severe stresses incident to high compression.

The cylinder heads are fitted with air-starting, fuel-injection, suction and exhaust valves. The body of the fuel injection valve is made of bronze in two parts, so constructed that it can be removed without dismantling any of the levers. The needle valve is of nickel steel, ground to size and seated in the lower half of the valve body. This valve is closed by a heavy compression spring and forced open by a lever actuated by a cam mounted on the cam shaft. Burning plates that may be renewed are attached to the lower end of the injector and are held in place by a cone-shaped nut securely locked. The suction and exhaust valves are interchangeable, made of Tungsten steel. They are guided at the top to prevent side wear of the stems and are mounted in cages which are easily removed. The air-starting valves are of nickel steel, also guided above the spring to prevent side wear or bending.

The valves are actuated by a cam shaft of large diameter, driven by spiral gears and provided with Hess-Bright radial and thrust ball-bearings running in a bath of oil. The vertical shaft actuating the cam shaft is of the same material as the cam shaft and is driven by spiral gears from the crank shaft. The vertical shaft is also provided with Hess-Bright radial and thrust bearings submerged in oil. The cam levers are of cast steel with hardened tool steel rollers and pins with screw adjustment for clearance at the tappet end, bronze-bushed for rocker shaft bearings.

The entire system of four pumps for cooling water, lubrication, fuel supply and bilge, which are located on the front of the crank case in a group, may be operated by hand with a single handle without disconnection or danger to the operator. The pumps are interchangeable, so that one can be substituted for another without delay.

The compressed air is furnished by a two-stage compressor with superimposed pistons driven directly from the main crank shaft. After being compressed to approximately 105 to 120 pounds per square inch in the first stage, the air is delivered to an intercooler and then to the high-pressure stage, where it is compressed to about 825 to 975 pounds per square inch, after which it is delivered to a second cooler and then stored in a small air receiver for fuel injection. As the compressor is designed to deliver more air than is required for fuel injection, the surplus is stored in two large receivers at a pressure of from 700 to 1,000 pounds per square inch for starting. The pressure in the injection air varies with the load; that is, from 800 pounds for half load to 975 pounds for full load, or 1,000 pounds for 10 percent overload.



3-Cylinder, 50-Horsepower Fulton (Diesel Type) Oil Engine

Forced lubrication is supplied to all the crank shaft bearings and wrist pins. The crank shaft is drilled through its entire length and a small self-priming rotary pump circulates the oil from the engine bed to all bearings located inside the crank case and up through the hollow connecting rods to the wrist pins. A greater quantity of oil than is actually needed for lubrication is supplied, thus cooling the bearings without waste, as the oil flows back to the crank chamber, where it is filtered and used over agin. An overflow valve in the system regulates the amount of pressure, which is normally held at 15 pounds. The entire oiling arrangement is automatic in starting and stopping with the engine.

The speed of the engine is controlled by a governor of the centrifugal type, with exposed adjustment mounted on the vertical shaft and supplied with a hand control to increase or decrease the engine speed at the will of the operator by regulating the amount of oil delivered by the fuel pumps.

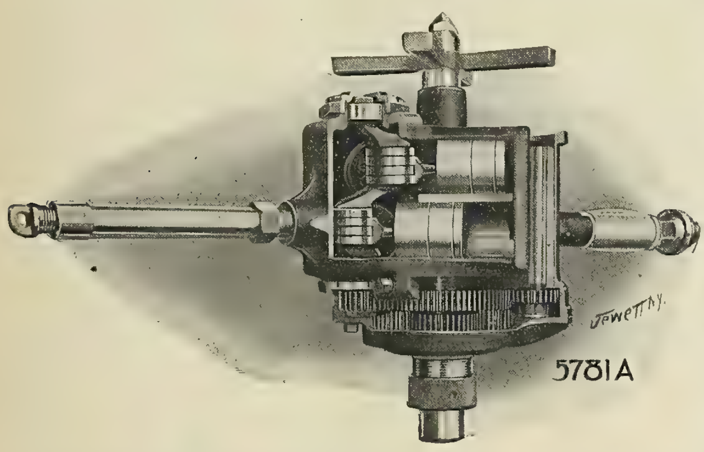
A handle and hand wheel supplemented by interlocking push buttons enables the operator to control every movement of the engine. The handle has three positions, namely, "barring," "air start" and "running." The push buttons serve to connect or by-pass the fuel for any cylinder when the handle is in the position for running. These buttons are so interlocked with the handle that starting air and fuel cannot be supplied to a given cylinder at the same time. The hand wheel serves to put more or less load on the governor, thereby controlling the speed of the engine.

The Fulton Diesel engine is manufactured by the Fulton Manufacturing Company, of Erie, Pa., who make a guarantee of a fuel consumption of .55 pound of oil per horsepower hour. In a recent test, however, the results of which are given below, the actual consumption of a 50-horsepower engine was only .5 pound of oil per hour.

	Cost per Hour.	Cost per 100 Hours.
50 h. p. 4-cycle gasoline (petrol) engine, 6 gals. gasoline (petrol) at 16 cents (0/8) per gal.	$0.96 (4/0)	$96.00 (20/0/0)
50 h. p. 4-cycle kerosene (paraffin) engine, 7 gals. kerosene (paraffin) at 8 cents (0/4) per gal.	.56 (2/4)	56.00 (11/13/4)
50 h. p. steam engine, 200 lbs. of coal at $5.00 (1/0/10) per ton	.50 (2/1)	50.00 (10/8/4)
50 h. p. semi-Diesel oil engine, 4¼ gals. of oil, at 4½ cents (0/2¼) per gal.	.19 (1/8)	19.12½ (3/19/8)
50 h. p. Diesel engine, 3½ gals. of oil at 4½ cents (0/2¼) per gal.	.15 (3/4)	15.75 (3/5/7½)

Improved "Little David" Drill

A noteworthy advance in the pneumatic tool line is the improved "Little David" drill which was brought out a short time ago by the Ingersoll-Rand Company, of New York and London. This is the only drill on the market having connecting rods running on roller bearings combined with crankshafts running on roller-bearings. In addition, the new tool has all the advantages of the previous type, such as unusual accessibility to all parts, absence of hinged joints on the connecting rods, and cylinder heads cast integral with the drill casing. The fewness of parts and general simplicity of the tool are striking features.



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The shell is so designed that the entire motor apparatus may be assembled or disassembled through the crank case by the removal of the cover. The motor, or engine, is of the angular, four-cylinder, single-acting, reciprocating piston type, each pair of pistons being attached to opposite throws of a double crankshaft, and each acting in balance. All four connecting rods are exactly alike and are interchangeable. Each consists of but a single part, made by drop-forging a piece of selected steel.

The connecting rods run on Hyatt roller bearings, which it is claimed greatly reduce friction and give an easier running tool. The connecting rods are attached to the pistons by ingenious spring arrangements, whereby ease of assembling is secured. The piston ends of the rods are ball-shaped, over which flat steel springs are slipped. These balls have their bearings in the center of the pistons, forming ball and socket joints, permitting the connecting rods to yield to pressure from any direction without causing the pistons to bind in the cylinder. This construction also permits the pistons to turn in the cylinders, so that wear is evenly distributed.

The crankshaft works in F. & S. silent-type ball bearings. These bearings are of the separator type, which it is claimed is superior to the full type of bearings for machines of this character operating at medium and high speeds, as, in the full type of construction, the balls come in contact and wear flat rings in their circumferences in very short time, resulting in loose bearings and generally unsatisfactory operation. The rapid wear is largely due to the fact that the balls are rotating in opposite directions at their points of contact, and the wearing effect is therefore doubled. The spindle is provided with a ball thrust bearing interposed between the shell and feed spindle, in such manner that the main frame is relieved of all thrust or strain.

Each valve controls two pistons which act on alternate strokes. As the valves are completely balanced, and of the rotating type instead of reciprocating, wear is equalized. The valves are geared to the crankshaft through the medium of a spindle gear. The valves are steel, hardened and ground, operating in bronze-bushed chests, giving a combination of two of the best wearing surfaces. The setting of the valves is very simple, as it is merely necessary to see that the letters stamped on the valve and crankshaft pinions register with letters on the main gear.

These tools may be made reversible or non-reversible at the will of the operator. This is accomplished by changing the position of the sliding sleeve on the throttle handle. With the exception of the light wood-boring type, all sizes are provided with compound gearing, insuring great power at all speeds.

The "Little David" drill is made in five sizes. No. 1 is for heavy drilling, reaming, tapping and flue rolling; No. 2 is for similar work of a lighter nature; No. 3 is for light drilling and reaming. The No. 12 size is fitted with a chuck for a 4-inch wood-boring auger, and the No. 13 size has a chuck for a 2-inch wood-boring auger.

Personal

A. L. Hopkins has been elected president and Homer L. Ferguson, vice-president, of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va.

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ALDRICH PUBLISHING CO.,
H. L. Aldrich, President and Treasurer.

Sworn to and subscribed before me this 12th day of March, 1914.

Oscar M. Pickruhl.
(My commission expires March, 1915.)

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

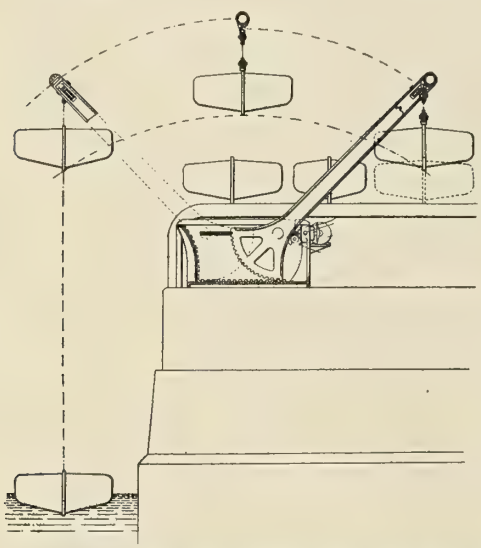
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,083,597. NAVIGATOR'S SPEED INDICATOR SHIP'S LOGS. HENRY H. CUMMINGS, OF NEWTON HIGHLANDS, MASS.

Claim 1.—In an apparatus indicating means to indicate the theoretical travel of the ship through the water, means to vary at will the action of said indicating means, and operating mechanism, including separate counters, one for each engine, for operating said indicating means in response to the mean revolutions of said ship's engines, said counters indicating at the same time the actual separate revolutions of the respective engines. Eighteen claims.

1,086,309. CRANES OR DAVITS. GUSTAF RENNERFELT AND ANDREAS P. LUNDIN, OF NEW YORK, N. Y., ASSIGNORS, BY MESNE ASSIGNMENTS, TO ASTOR TRUST COMPANY, TRUSTEE, A CORPORATION OF NEW YORK.

Claim 1.—The combination of a davit, a track to support it, a nut mounted pivotally in the davit, a frame joined with the track, a casing mounted on trunnions in the frame, a worm-shaft projecting with



both ends through the casing and threaded into the nut, and end-thrust bearing and a radial bearing for the worm, both said bearings being contained within the casing, and means for rotating the worm. Fifteen claims.

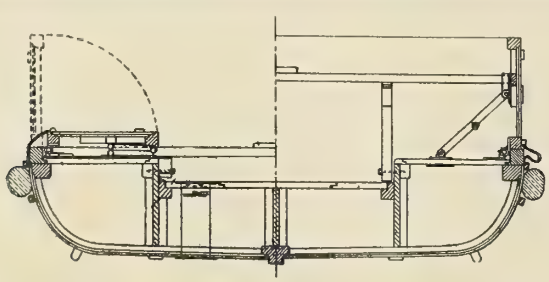
1,083,448. FITTING SUBMARINE SIGNALING APPARATUS IN VESSELS. SIMON LAKE, OF MILFORD, CONN., ASSIGNOR TO LAKE TORPEDO BOAT COMPANY, OF BRIDGEPORT, CONN., A CORPORATION OF MAINE.

Claim 1.—In combination with a submarine or submersible torpedo boat having an air-tight compartment in the hull thereof, a housing fixed to the hull of the boat in said compartment and surrounding an opening in the hull and opening to the exterior of the boat, and a sound producing apparatus supported by the housing with its resonant body extending into said housing and fixedly supported beyond the outer lines of the hull, said apparatus forming a closure for the inner end of the housing within said air-tight compartment. Six claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

10,432/1913. COLLAPSIBLE OR PARTIALLY COLLAPSIBLE BOATS. H. McLEAN, of 1 WATER ROW, GOVAN, GLASGOW.

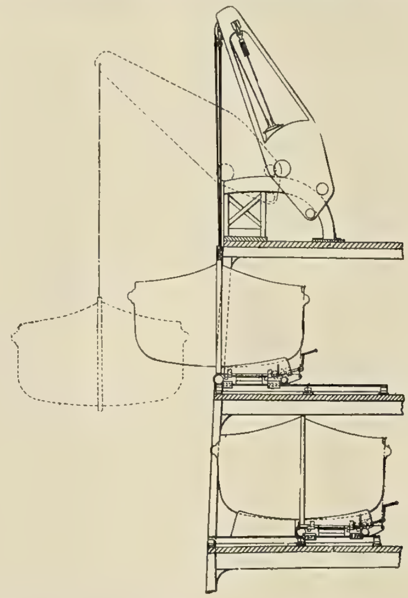
Claim.—Under this invention an improved collapsible boat consists of a lower structure or hull, sub-divided into compartments and decked over



its entire length, a portion of the deck being relatively lowered so as to constitute a sunk well provided with relieving tubes for draining water and discharging it into the sea; a collapsible upper structure follows the deck line to the extremities of the boat, the sides of which structure are made of rigid material and hinged inboard along the straight of the boat side, whilst its fore-and-aft ends are made of flexible material suitably supported and hingeably secured to the deck.

1,193/1913. STORING AND HANDLING SHIP'S BOATS. THE MARTIN PATENT DAVIT CO., LTD., AND A. J. LEWOWICZ OF 9 UNION COURT, LIVERPOOL.

Claim.—According to this invention there is provided on one or more decks, below the deck, on which is mounted a pair of davits, athwartship rails, on which a carriage carrying a lifeboat can move in such a way that in its normal position the boat shall be well inboard of the



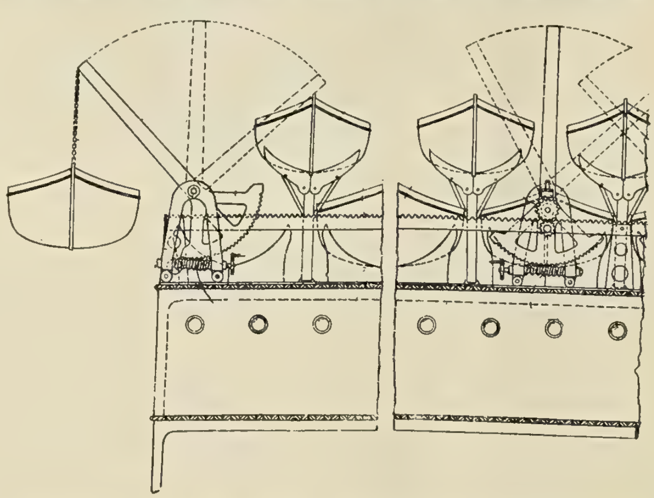
ship's side, but that when the boat is required for use it may be propelled outboard so that it can be lowered by the davits on the top deck. The rails are formed in sections which are hinged so that they may be folded back out of the way. In this manner one pair of davits on the top deck may serve not only a boat or boats on its own deck but also a boat or boats on one or more lower decks.

1,194/1913. APPARATUS FOR LOWERING SHIPS' BOATS. THE MARTIN PATENT DAVIT CO., LTD., AND A. J. LEWKOWICZ, OF 9 UNION COURT, LIVERPOOL.

Claim.—According to this invention, in order that the boat shall be lowered on an even keel, each fall is led back to a separate drum, the two drums being arranged co-axially side by side, but while one is fast with the brake and hoisting machinery, the other is not fast and a clutch is provided by means of which the loose drum can be uncoupled from the fast drum and locked in a fixed position so that the fast drum can be rotated in one direction or the other independently of the other drum to adjust the level of the boat. The clutch is preferably so formed that the loose drum is locked before it is disconnected from the fast drum.

23,448/1912. IMPROVEMENTS IN OR RELATING TO THE STOWAGE AND LAUNCHING OF SHIPS' BOATS, RAFTS AND THE LIKE. D. MACDONALD, DEPUTY MARINE SUPERINTENDENT, BRITISH INDIA STEAM NAVIGATION COMPANY, LTD., AT BOMBAY.

A davit of the type which can swing freely about a center in a vertical plane toward and from the water is trunnioned in a block which can be moved along athwartship guides by means of screw shafts, into



a position adjacent to any boat in a group placed inboard of one another, and put into an upstanding or sloping position, as may be desired, the swinging of the davits being performed by toothed quadrant on the lower end of the davit, controlled by a worm journaled in a bracket fixed to the block.

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Largest Oil Tankers in the United States

Description of First of Two Large Oil Tank Steamers Built for the Standard Oil Company at Newport News, Va.

The tank steamer *John D. Archbold,* whose speed trials took place on March 11, and a duplicate oil tanker to be named the *John D. Rockefeller,* now on the ways of the Newport News Shipbuilding and Dry Dock Company, Newport News, Va., have the distinction of being the largest tankers built or building in the United States. The contract for these vessels was placed with the Newport News yard by the Standard Oil Company of New Jersey.

The *John D. Archbold* was built under the special survey of Lloyds Register of British and Foreign Shipping to Class A-1 for shelter deck, longitudinally-framed vessels. She is designed to carry petroleum in bulk, and the shelter deck is fitted to provide sufficient strength and freeboard. Panama and Suez Canal certificates have been issued to the vessel. The accompanying plans and midship section illustrate the general arrangement and structural scantlings. The principal dimensions are as follows:

Length over all	474 feet 6 inches
Length between perpendiculars (Lloyds)	460 feet
Beam, molded	60 feet
Depth, molded to shelter deck	36 feet 2 inches
Depth, molded to upper deck	28 feet 8 inches

The designed deadweight capacity is 10,000 tons, which includes cargo, fuel, fresh water, stores, etc., on a mean draft not exceeding 23 feet 4 inches in salt water, with a coefficient not to exceed .805. The vessel is arranged to trim on an even keel with a draft of 22 feet when carrying a total deadweight of 9,000 tons, 8,600 tons of which will be cargo oil in the main tanks, the remaining 400 tons consisting of fuel, water and stores.

General Arrangement

The vessel is built with longitudinal framing. The hold is divided into nine tanks for carrying cargo oil with a centerline bulkhead extending to the upper deck, dividing these tanks into port and starboard compartments. The spaces in way of the expansion trunk at the sides of the ship are divided into four compartments on each side to be used for summer oil tanks. The hold forward of the cargo tanks, and the space forward of the coal bunker under the shelter deck are for carrying case oil, or other package freight. Cofferdams are fitted between the cargo holds and the oil tanks at the forward end, and between the fuel oil tank and the cargo oil tanks aft. The pump room is located amidships, and there is a deep tank under the forward hold. The machinery is located aft, and a double bottom is fitted under the fuel tank and the machinery spaces.

There are three decks, the main, upper and shelter. The space under the shelter deck, abreast the boiler casing, extending forward to amidships, is arranged for use as a coal

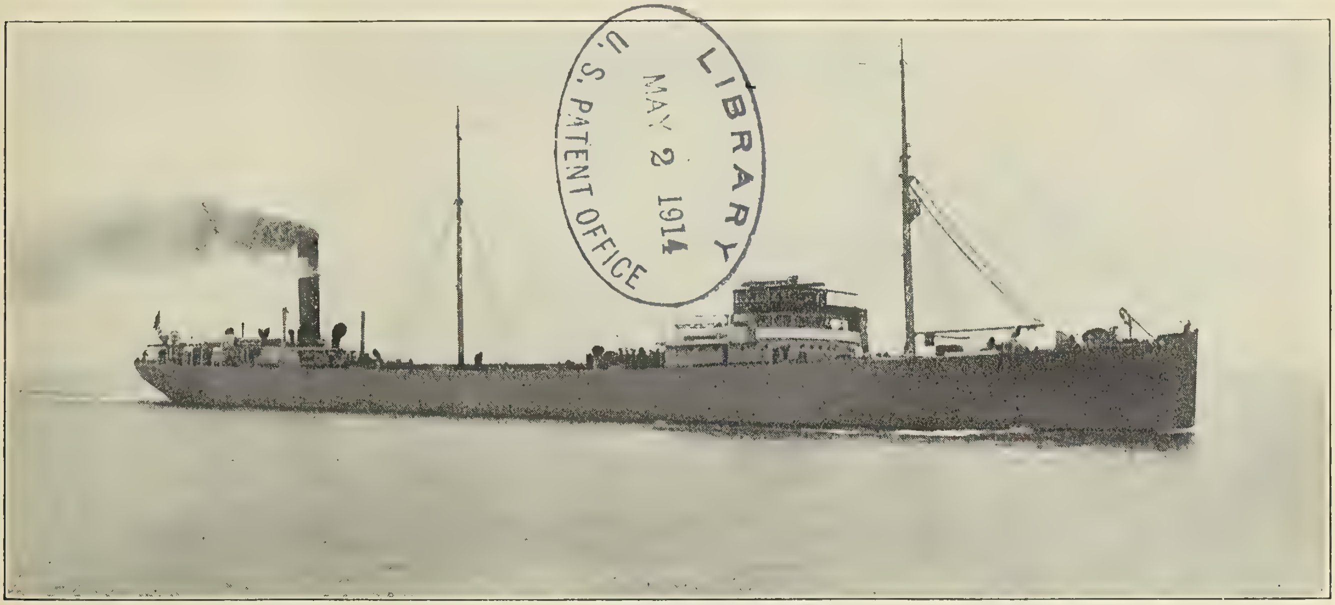


Fig. 1.—Oil Tank Steamer *John D. Archbold*, of 10,000 Tons Deadweight Carrying Capacity

bunker. The fuel tank is arranged for carrying either coal or oil fuel, although for the present the vessel will use coal for fuel. The main and summer tanks and the fuel oil tanks extend to the upper deck only, and the space at the hatches between the main and shelter decks is bulkheaded off from the rest of the shelter deck space to prevent fumes from settling under the shelter deck.

Machinery

The propelling machinery consists of one 4-cylinder quadruple-expansion engine, with cylinders 24, 35, 51 and 75 inches diameter by 51 inches stroke. The high-pressure and first intermediate-pressure cylinders are fitted with piston valves, while the second intermediate and the low-pressure cylinders are fitted with double-ported slide valves. All of the valves

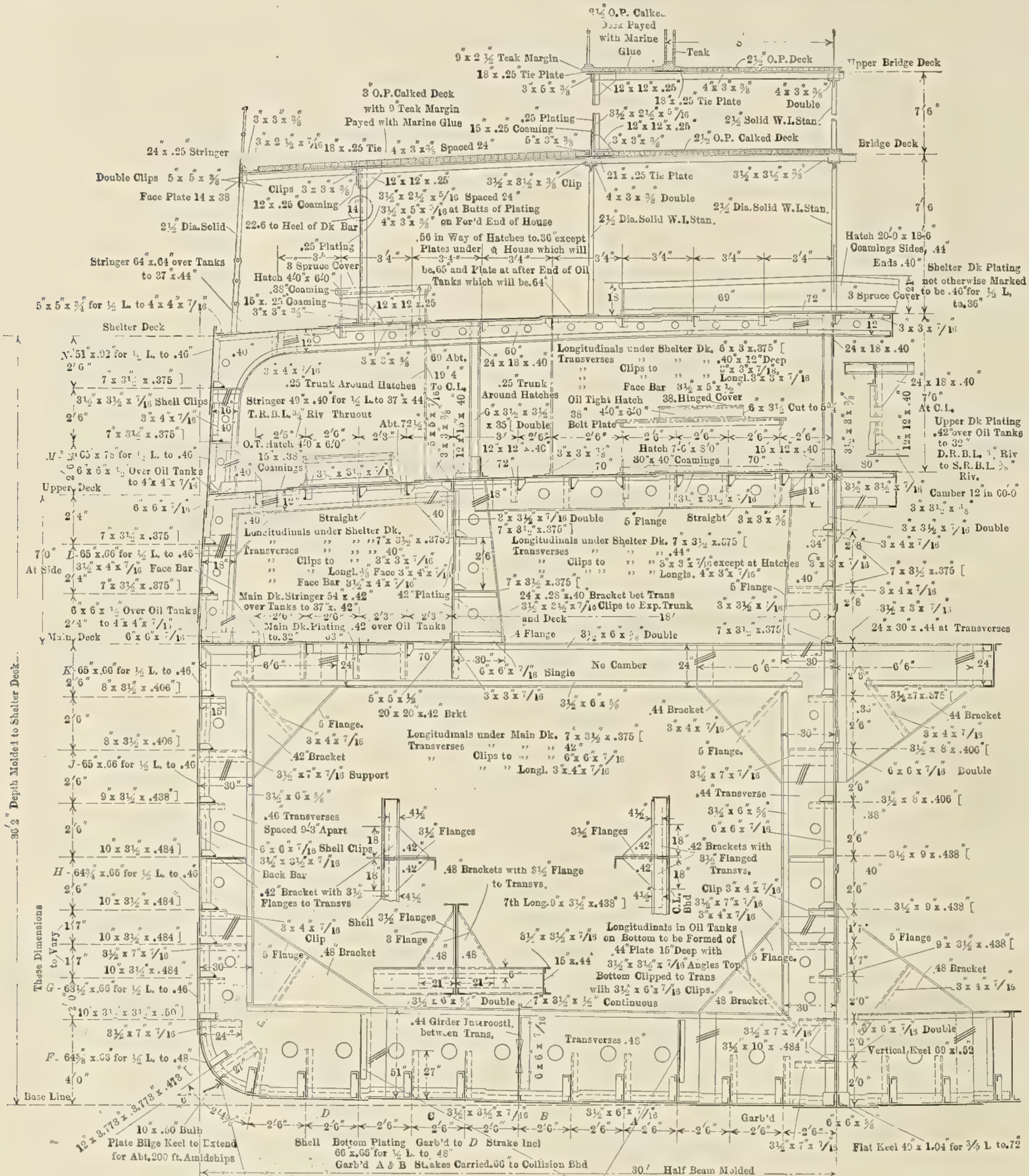


Fig. 2.—Midship Section

The rigging consists of two pole masts, schooner-rigged. Accommodations for the officers, purser and doctor, together with the pantry and dining saloon, are located in a deck house amidships, while the galley is on the shelter deck aft. The engine room crew, firemen, sailors, quartermasters and bos'n have quarters under the shelter deck aft.

The equipment of the vessel is very complete, including a submarine signal receiving set, and wireless apparatus with accommodations for two operators. Lifeboats with a total capacity which is double the number of persons on board are provided, consisting of two 24-foot steel boats and two 24-foot wooden boats

are controlled by Stephenson link motion. The reverse gear is of the direct-acting type, driven by a reversing cylinder 14 inches diameter by 24 inches stroke.

The bedplate of the main engine is of the cast iron box type, made in sections, with eight main bearings fitted with water circulators and lined with white metal; the top bearing is of cast steel in one piece. The crank shaft is of the built-up type with interchangeable sections. The propeller is of the four-bladed sectional type with manganese bronze blades and cast iron hub. The diameter is 17 feet 6 inches and the pitch 16 feet 6 inches.

An independent condenser of the cylindrical type with steel

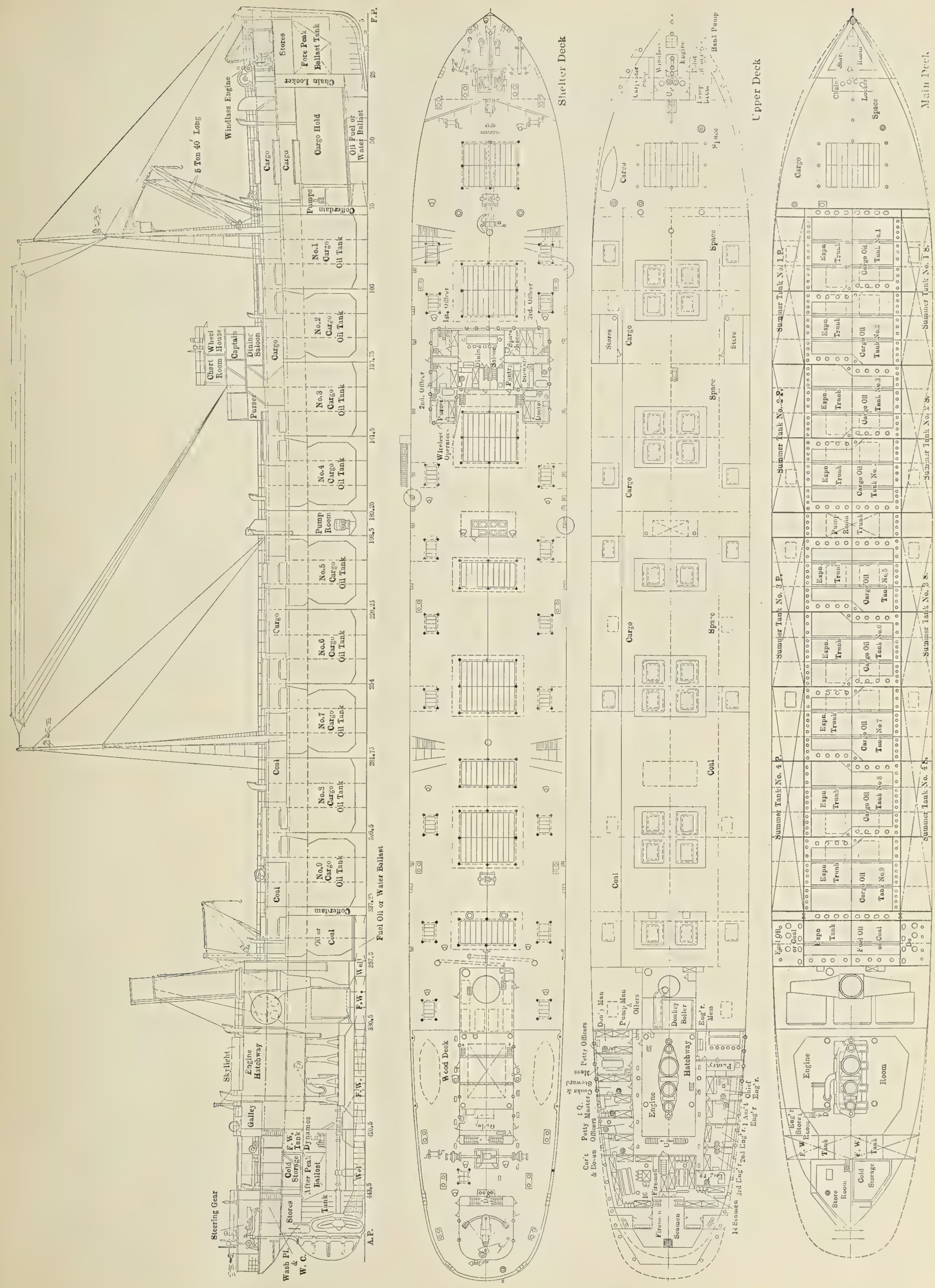


Fig. 3.—Profile and Deck Plans of the Oil Tank Steamer *John D. Archbold*

shell and Muntz metal tube plates and ¾-inch Admiralty mixture tubes provides a cooling surface of 4,200 square feet. The air pump is of the Edwards type, 26 inches diameter and 24 inches stroke. Cooling water is supplied by an independent centrifugal pump with two direct-acting engines, one of which will do the work, the other standing by as a spare.

Steam is supplied at a pressure of 220 pounds per square inch by three single-ended Scotch boilers, each 14 feet 4 inches mean diameter and 11 feet 6 inches long, arranged for Howden's system of forced draft. The combined heating surface of the boilers is 7,035 square feet, and the total grate surface 177 square feet. Each main boiler is fitted with Stewart circulators. As previously stated, the boilers will be coal-fired at present.

A donkey boiler, 10 feet 11 inches inside diameter by 10 feet 10½ inches long, is located at the main deck in the boiler casing. The heating surface is 1,223 square feet, and the grate area 39 square feet. The boiler is designed for a working pressure of 180 pounds per square inch.

Two duplex National Transit oil pumps, 18 inches by 14 inches by 24 inches, are connected to the cargo pumping system. The cargo tanks are fitted with fire extinguishing connections and heater coils.

Two General Electric vertical engine generating sets of 20 kilowatts capacity each furnish light for the vessel, and current for the ventilating fans. The deck machinery includes a Hyde windlass with quick warping drums, three warping winches with extra large gypsy heads and a Brown tiller.

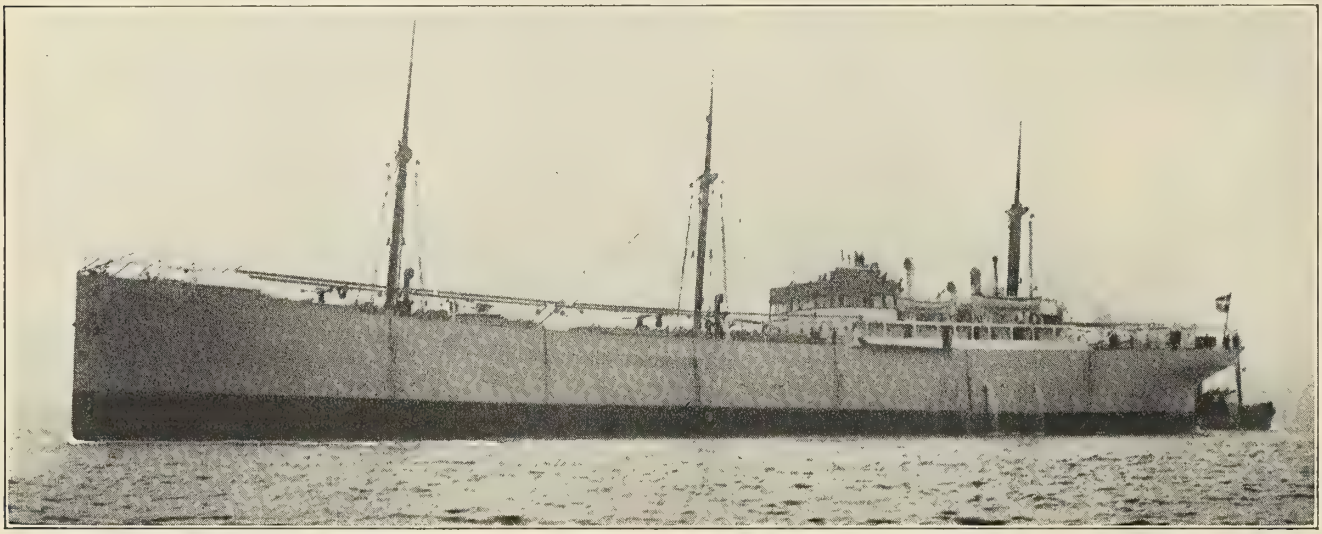
On trial, a speed of 12.3 knots was maintained, the engines developing 3,400 indicated horsepower. It is stated that the power was developed with a very low coal consumption.

Lake Launchings

The steamer *D. W. Crawford,* building for the Virginia Steamship Company, was launched April 18 at the Lorain yard of the American Shipbuilding Company, and the steamer *W. H. Donner,* building for the Mahoning Steamship Company, was launched May 2 at the Ashtabula yard of the Great Lakes Engineering Works. Both of these ships are duplicates in all essential details and of the following dimensions: Length overall, 524 feet; keel, 504 feet; beam, 54 feet; depth, 30 feet. They are built upon the Isherwood system of longitudinal framing, and will carry in the neighborhood of 9,000 tons. Triple-expansion engines are installed having cylinders 23½ inches, 38 inches and 63 inches diameter and a stroke of 42 inches. Two Scotch boilers, each 15 feet, 4½ inches mean diameter by 12 feet long overall, built for a working pressure of 180 pounds per square inch, will supply steam for all purposes. Both of these ships replace vessels lost in the storm of November last, and they have been designed with all possible care and with the experiences of that storm as a guide; hence they should prove very stable and satisfactory ships for their intended service. They have been built to meet the requirements of the Great Lakes Register and British Lloyd's.

Motor Ship Kronprins Gustaf Adolf

Trials of the motor ship *Kronprins Gustaf Adolf,* the third motor ship built by Burmeister & Wain, Copenhagen, Denmark, for Rederiaktiebolaget Nordstjernan, Stockholm, were carried out in Copenhagen Sound March 15, although, on account of foggy weather, it was impossible to make them complete. After the trials, however, the ship sailed to Frederiksstad and Göteborg to take on cargo, and a final trial trip with full load was then carried out on the 24th. The dimensions of the ship are as follows:



Twin-Screw Motor Ship *Kronprins Gustaf Adolf,* Equipped with Two Six-Cylinder Main Engines of 1,000 Horsepower Each

Length	362 feet
Beam	51 feet 3 inches
Depth	23 feet 1 inch
Deadweight	6,550 tons

The new vessel is a sister ship to the *Suecia* and *Pedro Christophersen,* which Burmeister & Wain recently built for the same owners. The engine installation of the *Kronprins Gustaf Adolf* differs from that in the other ships, however, in that the main engines have six cylinders instead of eight, as in the other ships. The two main engines are each of 1,000 brake horsepower, the dimensions being 21.6 inches cylinder diameter, 29.2 inches stroke, and 140 revolutions per minute. In other respects the machinery is the same as in the vessels formerly delivered.

The normal speed of the ship is 10 knots, and the maximum speed 10¾ knots, although on the trial trip a maximum speed of 11.83 knots was attained. The oil consumption worked out at .337 pound of Rumanian crude oil per indicated horsepower per hour for all purposes, including the oil used in the auxiliary machinery, which gives a fuel consumption of .397 pound per shaft horsepower hour.

After the full load trials, the ship proceeded on her first voyage to South America.

Measurement of Strains in a Ship's Hull*

New Type of Gage Used to Measure Strains in Hull of Ship at Sea and While Receiving Cargo—Results Obtained on Typical Voyage

BY JAMES E. HOWARD†

Strain gage measurements were made on the plates of the shelter deck of the steamship *Ancon*, of the Pacific Railroad Steamship Company, on a voyage from New York to Colon and return, and subsequently during the time the ship was taking cargo aboard at New York.

The *Ancon*, originally called the *Shawmut*, was built by the Maryland Steel Company, Sparrow's Point, Md., in 1902. It has the following dimensions:

Length, 505 feet; beam, 58 feet; depth, 41 feet. Displacement at 30 feet draft, 20,830 tons.

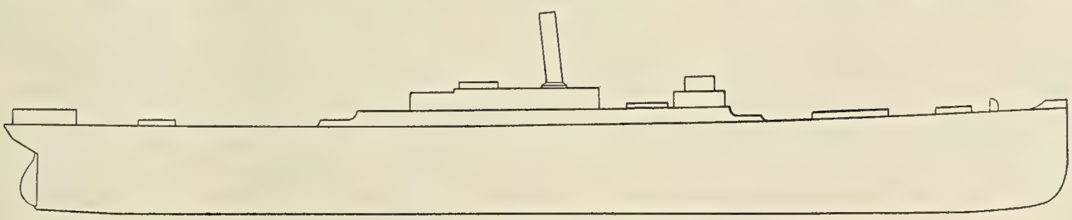


Fig. 1.—Outboard Profile of *S. S. Ancon*

It has twin screws, and is equipped with triple-expansion engines, with cylinders 24 inches, 39½ inches and 62 inches diameter, and 45 inches stroke, making 78 revolutions per minute. The steam pressure carried is 200 pounds, and the ship makes a speed of about 12 knots.

For a time the ship was used in the China trade, but of late she has been used in the transportation of structural materials for the Panama Canal, of which cement usually formed the principal part of the cargo.

Live load strain measurements were made on the deck plating while the ship was at sea, using a new type of extensometer designed by the writer, a scissors gage (Fig. 2), so-called from the resemblance of its working parts to a pair of scissors.

The Strain Gage

It consists of two beams, which, taken together, are rectangular in outline, and between which are located two small bell crank levers. Parallel motion of the beams is secured by the use of flexible stay plates. The bell crank levers are mounted upon fulcrums made of thin plates of tempered steel. They work in opposite directions. The long arms of the levers are blades which make with each other a small angle, the vertex of which or point of intersection of the blades marks the place where the reading of the instrument is taken.

The blades are comparatively light, the beams are relatively heavy. The instrument is dust proof. The proportions of the parts are such that a change in the position of the point of intersection of the blades of 1 inch in length represents a movement of the beams, or measured movement of one-thousandth of an inch. The index plate is graduated into ten parts, each representing one ten-thousandth of an inch. A change in position of the point of intersection of .01-inch on the scale represents one one-hundred-thousandth of an inch movement of the beams. The gage has a total range of movement, or full scale reading of one-thousandth of an inch.

Since the range of the instrument is quite limited it is necessary to establish longer or shorter-gaged lengths on the measured member, according to the expected magnitude of the strains in order that they shall not exceed the capacity of the instrument. On the present occasion, the strains were generally small, and it was expedient to use extension rods which covered a length of 6 inches on the deck plates. The gage is shown in position on the deck in Fig. 3, where it

*A paper presented before the Society of Naval Architects and Marine Engineers, New York, December, 1913.
† Engineer-Physicist.

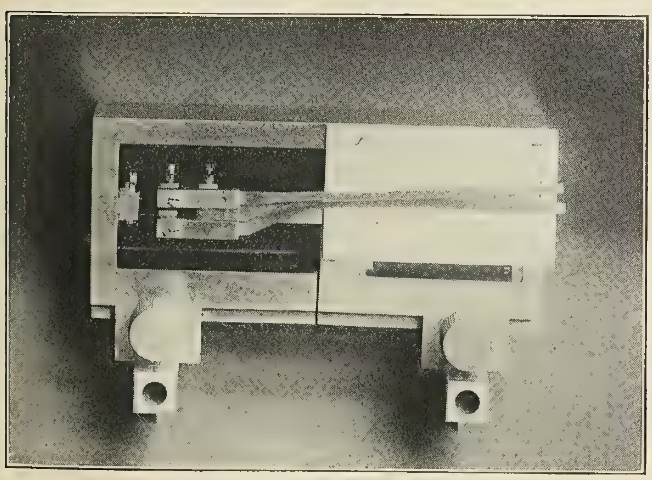


Fig. 2.—Scissors Gage

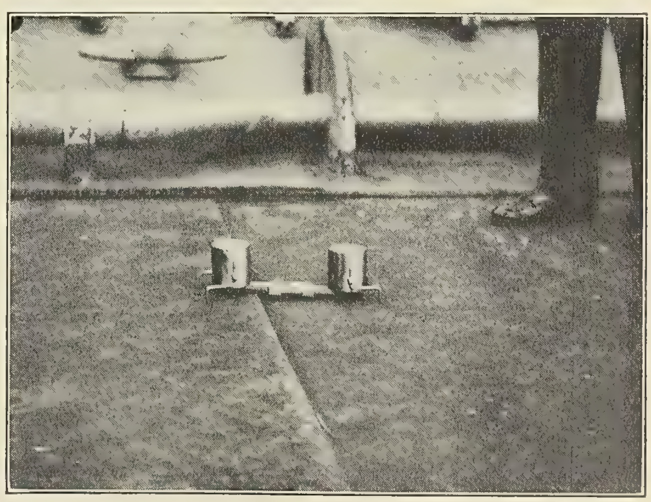


Fig. 3.—Scissors Gage Spanning Lap Joint on Deck Plates

appears spanning a lap joint, stepping down from one plate to another. Contact with the deck plates is made by means of conical steel points attached to the beams or to the extension rods. Sufficient roughness was found on the deck

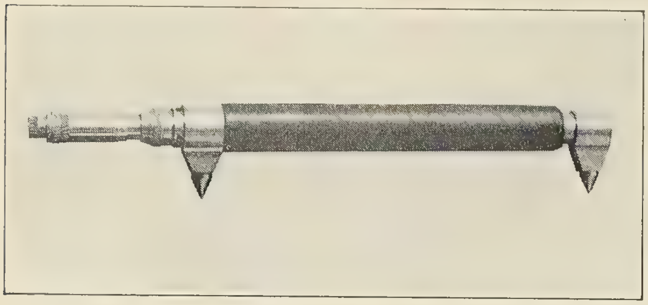


Fig. 4.—Strain Gage

plates to actuate the instrument when a weight was placed over each contact point, as illustrated in Fig. 3. The contact points could be placed in small holes made with a center punch in the deck plates if needed.

Moderate loads causing strains of a few hundred-thousandths of an inch, or slowly applied loads, can be measured with comparative ease, but the effects of rapidly-changing loads of considerable magnitude are less easily observed. The instrument is a new one and was used for the first time on this voyage. A number of modifications in its details will be made to facilitate taking readings, making it even a little more compact, and providing means for attaching it to different-shaped members and in different positions.

It responds promptly to changes in strains in the member under examination. Stamping upon the deck at a distance of 25 feet from the gage caused longitudinal vibrations which the instrument responded to. The results here presented are regarded as close approximations to the actual strains which were developed, but are not held to be rigorously exact.

A strain gage of the type shown in Fig. 4 was used for measuring the deck plates during the time cargo was being received. The gage employed had a working length of 20 inches. It is telescopic in design. There is an outer tube which carries a conical contact point near one end of the instrument, and an inner bar which carries a contact point near the opposite end. The longitudinal movement of the inner bar with reference to the outer tube, and consequently the movement of the contact points, is measured by

TABLE No. 1

Strains in Plates of Shelter Deck of S. S. Ancon When at Sea, Loaded with 10,217 Tons of Cargo
Draft About 29 Feet

Measurements with scissors gage, lengths of 6 inches each, on deck plating, port side of ship, on outward trip, New York to Colon, April, 1913. Observations on plates at middle of width and length, also stepping down from one plate to another, across triple-riveted lap joints. Position of ship, off easterly end of Cuba. Smooth sea. Forward part of ship.

Course of Plating	Plate		Gaged Length				Probable Effect of	
	No. of	Weight of, pounds	Location	On solid plate or joint	Measured Strain, Inches	Corresponding stress, pounds per square inch	Engines	Pitching
C	27	22	Just aft breakwater	Solid plate	No strain detected			
C	26 to 27	22	Abreast Hatch No. 1, just aft breakwater	Joint	.00006			
C	26	22	" " " 1	Solid plate	No strain detected			
C	25 to 26	22	" " " 1	Joint	.00006			
C	25	22		Solid plate	.00003			
C	24 to 25	22		Joint	.00012			
C	24	22	Abreast Hatch No. 2	Solid plate	.00002	100		
C	23	22	" " " 2	Solid plate	.00007	350	.00005	.00002
C	22 to 23	22	" " " 2	Joint	.00015		.00010	.00005
C	22	22	" foremast	Solid plate	.00013	650	.00008	.00005
C	21 to 22	22	" " "	Joint	.00032		.00020	.00012
C	21	22	" Hatch No. 3	Solid plate	.00005	250	.00003	.00002
C	20 to 21	22	" " " 3	Joint	.00015		.00010	.00005
C	20	22	Just aft forward bulkhead of superstructure	Solid plate	.00002	100	.00002	0
C	19 to 20	22	Aft forward bulkhead of superstructure	Joint	.00020		.00020	0
C	19	22	" " " "	Solid plate	.00002	100	.00002	0
C	18 to 19	22	Abreast forward end Hatch No. 4	Joint	.00030		.00030	
C	18	22	Abreast Hatch No. 4	Solid plate	.00010	500	.00010	
C	17 to 18	22	" " " 4	Joint	.00020		.00020	
C	17	22	Abreast, after end Hatch No. 4	Solid plate	.00005	250	.00005	
C	16 to 17	22	Just forward of boiler hatch	Joint	.00030		.00030	
D	23 to 24	22	Abreast forward end Hatch No. 2	Joint	.00006			
D	22 to 23	22	Abreast Hatch No. 2	Joint	.00015		.00010	.00005
D	21 to 22	22	" after end Hatch No. 2	Joint	.00020		.00020	
D	20 to 21	22	" forward end Hatch No. 3	Joint	.00022		.00022	
Stringer	Butt strap to 25	30	" Hatch No. 2	Joint	.00003			
"	Butt strap to 24	32	" " " 2	Joint	.00003			
Stringer	23	22	" " " 2	Solid angle	.00002	100		
After Part of Ship.								
C	9 to 10	22	Just aft, after bulkhead of superstructure	Joint	About .00125		Abt. .00125	
C	9	22	Aft, after bulkhead of superstructure	Solid plate	.00020	1,000	.00020	
C	8 to 9	22	Abreast forward end Hatch No. 6	Joint	.00090		.00060	.00030
C	8	22	Abreast Hatch No. 6	Solid plate	.00030	1,500	.00030	
C	7 to 8	22	" " " 6	Joint	.00050		.00030	.00020
C	7	22	" " " 6	Solid plate	.00018	900	.00018	
C	6 to 7	22	" after end Hatch No. 6	Joint	.00026		.00016	.00010
C	6	22	Nearly abreast main mast	Solid plate	No strain detected			
C	5 to 6	22	Abreast main mast	Joint	.00010		.00005	.00005
C	5	22	Just forward of Hatch No. 7	Solid plate	No strain detected			
B	8	16	Just aft, after bulkhead of superstructure	Solid plate	.00045	2,250	.00045	
A	7	16	" " " " " "	" "	.00035	1,750	.00030	.00005
Stringer	Butt strap to 10	34	Aft, after bulkhead of superstructure	Joint	.00015		.00015	
Stringer Angle			Abreast forward end Hatch No. 6	Solid angle	.00025	1,250		
Bulwark rail			Aft, after bulkhead of superstructure	" "	.00026	1,300		
Earlier Observations made when a Moderate Sea was Running. Position of Ship, off Watlins Island.								
C	8	22	Abreast Hatch No. 6, 2 feet from coaming	Solid plate	.00050	2,500		
D	8	22	Abreast forward end Hatch No. 6	" "	.00070	3,500		
D	7	22	Abreast Hatch No. 6	" "	.00060	3,000		
Bulwark			Aft, after end of superstructure	Solid angle	.00110	5,500		

a screw micrometer attached to the outer member. The contact points are inserted in small drilled and reamed holes made in the deck plates, and when thus centered readings with the micrometer are taken.

The gage is used in connection with a steel reference bar, made of the grade of structural steel, and lengths on the deck are referred to this standard bar and recorded in terms of it. Concerning manipulative features, check observations, when the instrument is used under favorable conditions, commonly give the same ten-thousandths of an inch reading of the micrometer. In engineering structures in general it is not expected to define stresses much nearer than 500 pounds per square inch, which corresponds to a strain of three and one-third ten-thousandths of an inch in 20 inches length.

The deck plates of the ship afforded a better opportunity than usually experienced in making strain gage measurements on engineering structures; therefore, it is believed that these results are trustworthy in a higher degree than generally expected, that the strains were substantially as reported. In deducing the stresses corresponding to the measured strains, a value of 30,000,000 pounds per square inch was used for the modulus of elasticity of the steel plates.

A full cargo of 10,217 tons was carried on the outward voyage, while on the return voyage the cargo was only 3,000 tons.

Live Load Strains in the Deck Plating

Observations on the live load strains of the deck plating were made on both the outward and the return voyages. Good weather generally prevailed, hence the measured strains refer to conditions as they were found on a smooth sea with a minimum pitching of the ship. A few observations, however, were made on the outward voyage with a moderate sea running. With a low freeboard, when the ship carries a full cargo, the decks were generally wet in a moderate sea, and without protection it was impracticable to make many observations. The few measurements which were taken showed strains of increased magnitude, corresponding to the greater pitching of the ship which then occurred.

Tables 1 and 2 give the results of the measurements made at sea. Certain of these measured strains are entered upon diagrams of the deck plates and appear in Figs. 5, 6 and 7.

Referring to the observations in detail, and beginning at the forward deck, neither the solid metal of plate *C*, No. 27, over which the breakwater passed, nor that of the next plate aft, developed strains of sufficient magnitude to be measurable. At the first lap joint aft the breakwater, and across all succeeding joints, there was measurable deformation. The solid metal of plate *C*, No. 25, and those aft displayed measurable longitudinal strains, due either to the vibrations of the engines or to the pitching of the ship or to their combined effect.

The magnitude of the strains in general increased as the bulkhead of the superstructure was approached, although the rate observed was not a uniformly increasing one. The presence of hatches probably influenced the magnitude and distribution of the stresses. The smooth sea was favorable for acquiring comparative results on different parts of the ship. At times the engines on one shaft would gain in the number of rotations over those of the other, and differences in strains were noted which were attributed to the effects of the heavier pistons when those of both shafts were in the same phase.

Strains across the lap joints of courses *C* and *D* were substantially the same and much greater than those of the stringer plates. This behavior calls for the development of longitudinal shearing stresses at the seams betwen the stringer course and the adjacent course, but measurements necessary to follow these shearing strains were not included in the present series.

Pitching strains were not of sufficient magnitude to admit of measurement on the deck amidship, covered by the superstructure, but those caused by the engines were followed to a point nearly abreast the boiler hatch.

On the after deck the strains reached a maximum near the bulkhead. The movement across one of the lap joints exceeded the scale reading of the gage, and was estimated

TABLE No. 2

Strains in Plates of Shelter Deck of S. S. Ancon When at Sea Loaded with 3,000 Tons Cargo. Draft, 16 Feet 4 Inches Forward, 19 Feet 9 Inches Aft

Measurements with scissors gage, lengths of 6 inches each, on deck plating and bulwark rails, port side of ship, on return trip Colon to New York, May, 1913. Observations on plates at middle of width and length, also stepping down from one plate to another across triple-riveted lap joints. Light sea. After part of ship.

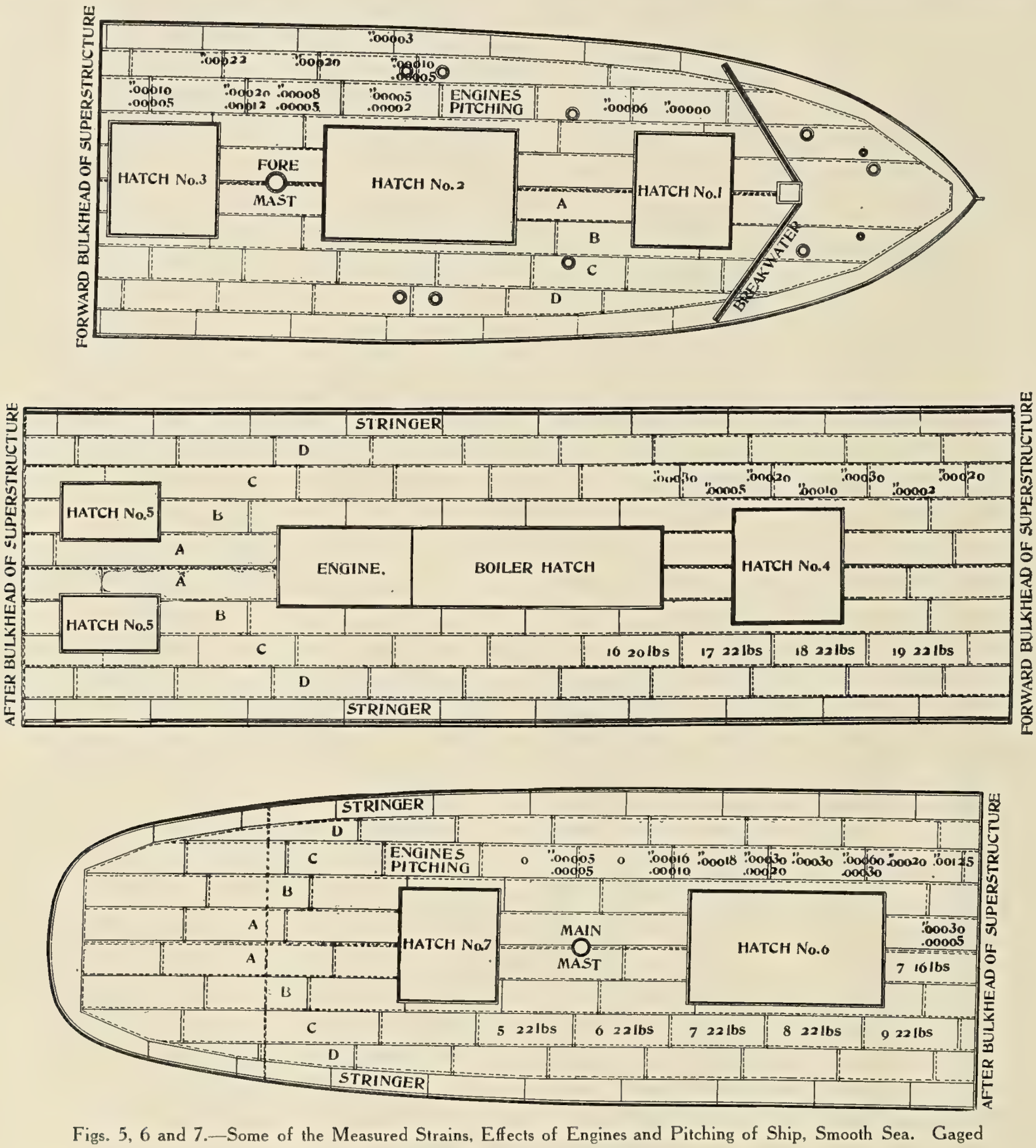
Course of Plating	Plate		Gaged Length				Probable Effect of	
	No. of	Weight of, pounds	Location	On solid plate or joint	Measured Strain, Inches	Corresponding stress, pounds per square inch	Engines	Pitching
C	9 to 10	22	Just aft, after bulkhead of superstructure	Joint	Estimated 3 times, scale reading			.00300 ±
C	8 to 9	22	Abreast forward end Hatch No. 6	"	.00075		.00005	.00070
C	8	22	" Hatch No. 6	Solid plate	.00022	1,100	.00002	.00020
C	7 to 8	22	" " " 6	Joint	.00070		.00010	.00060
C	7	22	" " " 6	Solid plate	.00010	500		
C	6 to 7	22	" after end Hatch No. 6	Joint	.00050		Perceptible	.00050
C	6	22	Nearly abreast main mast	Solid plate	.00018	900	"	.00018
C	5 to 6	22	Abreast main mast	Joint	.00040		"	.00040
C	5	22	Just forward Hatch No. 7	Solid plate	.00012	600		
C	4 to 5	22	Abreast Hatch No. 7	Joint	.00020			
C	4	22	" " " 7	Solid plate	.00004	200		
C	3 to 4	22	Abreast after end Hatch No. 7	Joint	.00040			
B	8	16	Just aft, after bulkhead of superstructure	Solid plate	.00022	1,100	0	.00022
D	8 to 9	24	" " " " " "	Joint	More than .00100		.00015	.00085 ±
Bulwark rail			Two feet aft after bulkhead of superstructure	Solid angle	.00045	2,250	.00005	.00040
				Smooth Sea.	After part of Ship.	Starboard Side.		
C	6 to 7	22	Abreast after end Hatch No. 6	Joint	.00040		.00005	.00035
C	6	22	Nearly abreast main mast*	Solid plate	.00012	600	0	.00012
C	4 to 5	22	Abreast Hatch No. 7	Joint	.00012		.00003	.00009
C	3 to 4	22	Aft, after end of Hatch No. 7	"	.00015		Perceptible	.00015
C	2	22	Near Bitts*		No strain detected			
Bulwark rail			Two feet aft, after bulkhead of superstructure	Solid angle	.00040	2,000		
Bulwark rail			Forward of superstructure	" "	.00055	2,750		

* Vertical vibrations in deck very pronounced at these places.
In vicinity of main mast very pronounced vertical vibrations, but no strains detected.

to be .00125 ±. Strains due to the engines were greater than those due to the pitching of the ship, both forward and aft the superstructure. This remark concerning the relative effect of the engines and the pitching of the ship refers to the observations made on the outward voyage. Northbound, with a light cargo, the relative effects of the engines and the pitching were reversed over those of the outward voyage, the pitching strains now predominating.

Strains due to pitching and those due to the engines were recognized by their periodicity. The engines made 78 revolutions per minute and strains attributed to them were developed synchronous with the revolutions.

In explanation of the relatively large movements due to the pitching of the ship when in comparatively smooth water, it appears probable that the lap joints of the deck plates had become loosened in a degree by exposure to repeated stresses.



Figs. 5, 6 and 7.—Some of the Measured Strains, Effects of Engines and Pitching of Ship, Smooth Sea. Gaged Lengths, 6 Inches. Full cargo

A comparison of results of the outward and return voyages is shown on Fig. 8. Whereas on the outward voyage a strain caused by the engines of about .00125-inch was observed at the lap joint of course *C*, next the bulkhead; on the return trip the effect of the engines was hardly perceptible at that place, but the pitching of the ship caused a movement estimated at three times the scale reading, or .003 ± inch. At other joints and on the solid plates similar results were observed, the pitching strains greatly predominating on the return voyage. All measurements were taken along the middle of the width of the several courses of plates.

A portion of the movement observed not unlikely represented slip of the joints. Of the effects which came from the engines there would be some seven hundred thousand to eight hundred thousand repetitions during one voyage to the Isthmus.

Places on the deck where the greatest longitudinal strains occurred were not usually accompanied with marked vertical vibrations. At least certain places where vertical vibrations were most pronounced, under the feet, were examined without finding unusual longitudinal strains. On the deck over the ridge bar on the starboard side, and also near the

main mast were places of pronounced vertical vibrations, but where the measured strains were of moderate extent. Again, at the stern, near the bitts, the vertical vibrations were very marked, while the longitudinal strains in the vicinity were not measurable.

Maximum Stresses Measured

The stresses corresponding to the measured strains, observed on the forward deck, ranged from 100 pounds to 650 pounds per square inch. On the after deck, 2,250 pounds per square inch was found, all referring to measurements made on a smooth sea. The stresses reached a maximum in the vicinity of the bulkheads of the superstructure, and disappeared as the bow or the stern was approached.

The observations which were made, prior to the main series, when a moderate sea was running, showed stresses on the after deck near the bulkhead ranging from 2,500 to 3,500 pounds per square inch. The highest stress observed was on the bulwark rail, where a stress of 5,500 pounds per square inch was found. Fig. 9 shows the place occupied by the strain gage on the angle of the rail when this observation was made.

The measured strains represent changes in length of the plates, and it was obvious at the time of their development which they were, whether they were in a tensile or a compressive direction as the gage successively opened and closed, but pre-existing strains in a finished structure at repose defy definition. In order to ascertain what strains exist in different parts of the ship, of tension and compression, or zero strains at neutral zones, it is necessary to establish reference lengths initially on the component members and remeasure them at desired stages. It involves considerable work to acquire reliable information upon the distribution of strains in the principal members of a ship, when launched, with the machinery installed, with a cargo aboard, and finally the live loads at sea, but it is entirely feasible to acquire such data, and in fairly complete detail. The method of measured strains devised by the writer, and which has been used in the investigation of internal strains in steel forgings since 1887, and more recently in the investigation of strains in engineering structures, admits of furnishing this information. This method of investigating strains was employed on the present occasion in measuring the deck plates during the time the ship was receiving cargo.

Strains Resulting from Loading Cargo and from Changes in Temperature

The purpose of making the strain gage measurements at the time of taking cargo aboard was primarily to ascertain what strains resulted directly from loading the ship. Notwithstanding the intent of the observations, the results evidently showed effects which were chiefly due to changes in the temperature of the plates, with obscure effects, if any, attributable to the cargo. With stevedore work going on at the several hatches few places on the deck were accessible at all times, or available even in the early hours of the morning, when most of the measurements were made. The places selected were just aft the bulkhead, as shown by Fig. 10.

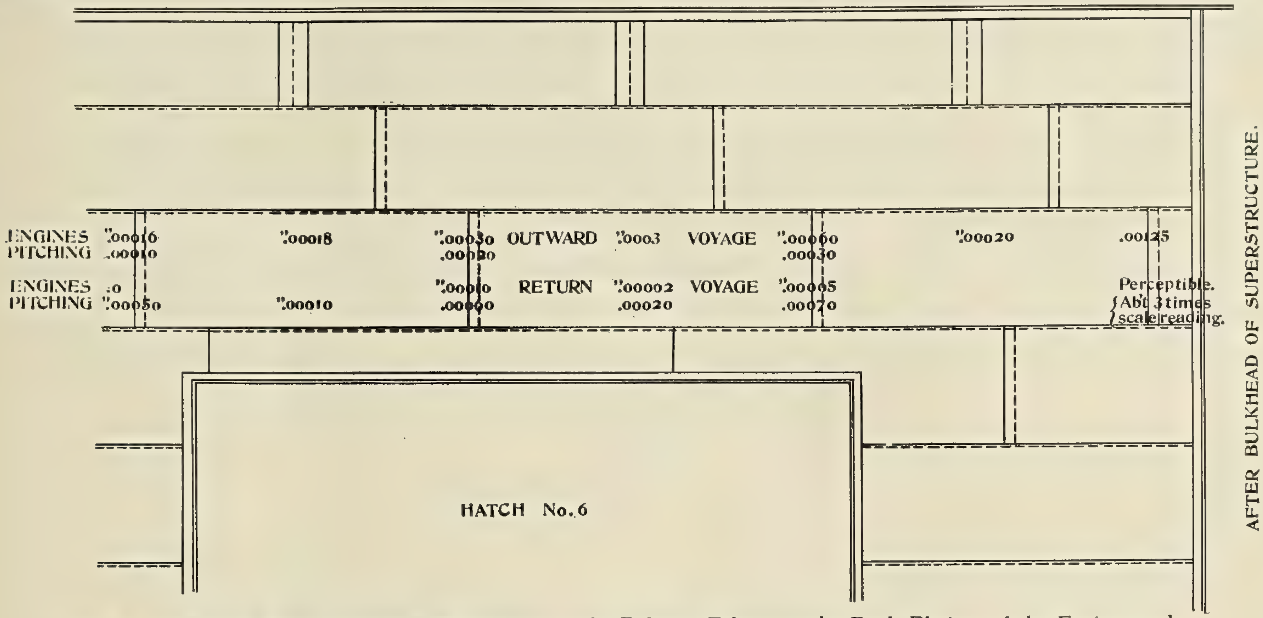


Fig. 8.—Measured Strains, Showing Differences in the Relative Effects on the Deck Plating, of the Engines and the Pitching of the Ship, According to Amount of Cargo Carried. Outward Voyage Made with 10,217 Tons Cargo; Return Voyage Made with 3,000 Tons Cargo

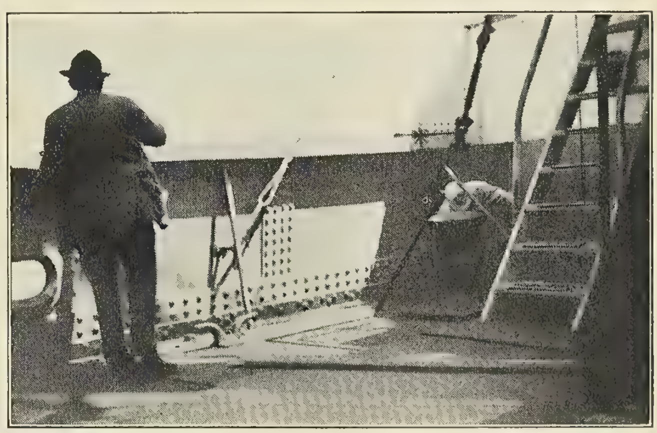


Fig. 9.—Place, Marked *, on Bulwark Rail where Maximum Strains were Observed

Reference lengths were established, of 20 inches each, on six courses of plating, three on each side of the ship, and one on each bulwark rail. The latter were on the angles directly over the double-riveted butt strap joints of the bulwarks. All reference lengths were fore and aft in their direction.

Measurements were inaugurated soon after the ship came out of dry dock, and were continued until the day of sailing. Fig. 11 shows a diagram upon which are entered the results of these measurements, also the temperature of the deck at each of the places measured, the hour of the day, and the draft of the ship forward and aft.

On June 13 the ship was at dock in Brooklyn, with bow heading East; on June 15 and 16 at Communipaw with bow toward the West. On succeeding days at Pier No. 52, North River, with the bow heading East. These changes in position introduced differences in thermal conditions which doubtless influenced certain of the measurements.

On the morning of June 20, sailing day, the temperature of the deck was nearly uniform, the range being from 64 to 67 degrees F. For convenience, the stresses were regarded as having zero value at that time, and the state of strain or strains on other days is given with reference to those on the day of sailing.

The manner in which the strain gage readings were taken and results arrived at were as follows: A reading is taken with the strain gage on the reference bar, followed by a reading with the gage on the deck plate. The distance or gaged length laid off on the deck is thus determined with reference to that laid off on the reference bar, the strain gage being used as a transfer instrument to compare one gaged length with another. The reference bar is assumed to have a length of exactly 20 inches. The temperature of the reference bar and that of the deck is noted. If they are not the same the reading for the deck length is corrected to correspond with that of the reference bar. The latter is made of structural steel or steel of that grade and assumed to have the same coefficient of expansion as the deck plates.

Assuming the strains to have zero value on the deck plates on some given day for comparison, on this occasion taking the lengths as they were measured on June 20, the individual lengths are said to be in tension or compression on other occasions according to their corrected lengths, that is, according to whether they were longer or shorter than on the day selected for comparison. Referring to examples on the diagram Fig. 11, the corrected gaged length of stringer plate No. 10, port side, on June 13 was .0019-inch shorter than it was on the 20th. The force required to shorten the plate this amount is 2,850 pounds per square inch compression. On June 16 the same gaged length, corrected, measured the same as on the day selected for comparison. It therefore had zero stress upon it with reference to its state on June 20. Again the gaged length was .0008-inch longer on the 18th, than on the day selected for comparison, which strain corresponds to a stress of 1,200 pounds per square inch tension.

The results exhibited on the diagram Fig. 11 were deduced in the maner described. Where stresses of tension are shown on the diagram the corrected gaged length on the deck was longer than it was found on the day selected for comparison, namely, June 20. Where stresses of compression are shown the gaged length was correspondingly shorter.

There was no change in the cargo between the time of measurements of June 15 and 16, but a wide difference in temperature, accompanied by a wide difference in the stresses. The starboard stringer plate passed through a range from 2,550 pounds per square inch compression to 1,050 pounds per square inch tension, a total of 3,600 pounds per square inch. This and other changes which occurred between those dates were clearly temperature effects.

Significance is attached to the similarity between the shaded parts of the diagram representing the stresses in the stringer plates and bulwark rails on June 13 and June 15, comparing the port side on the first day with the starboard side on the second day. The ship was moved between those dates from

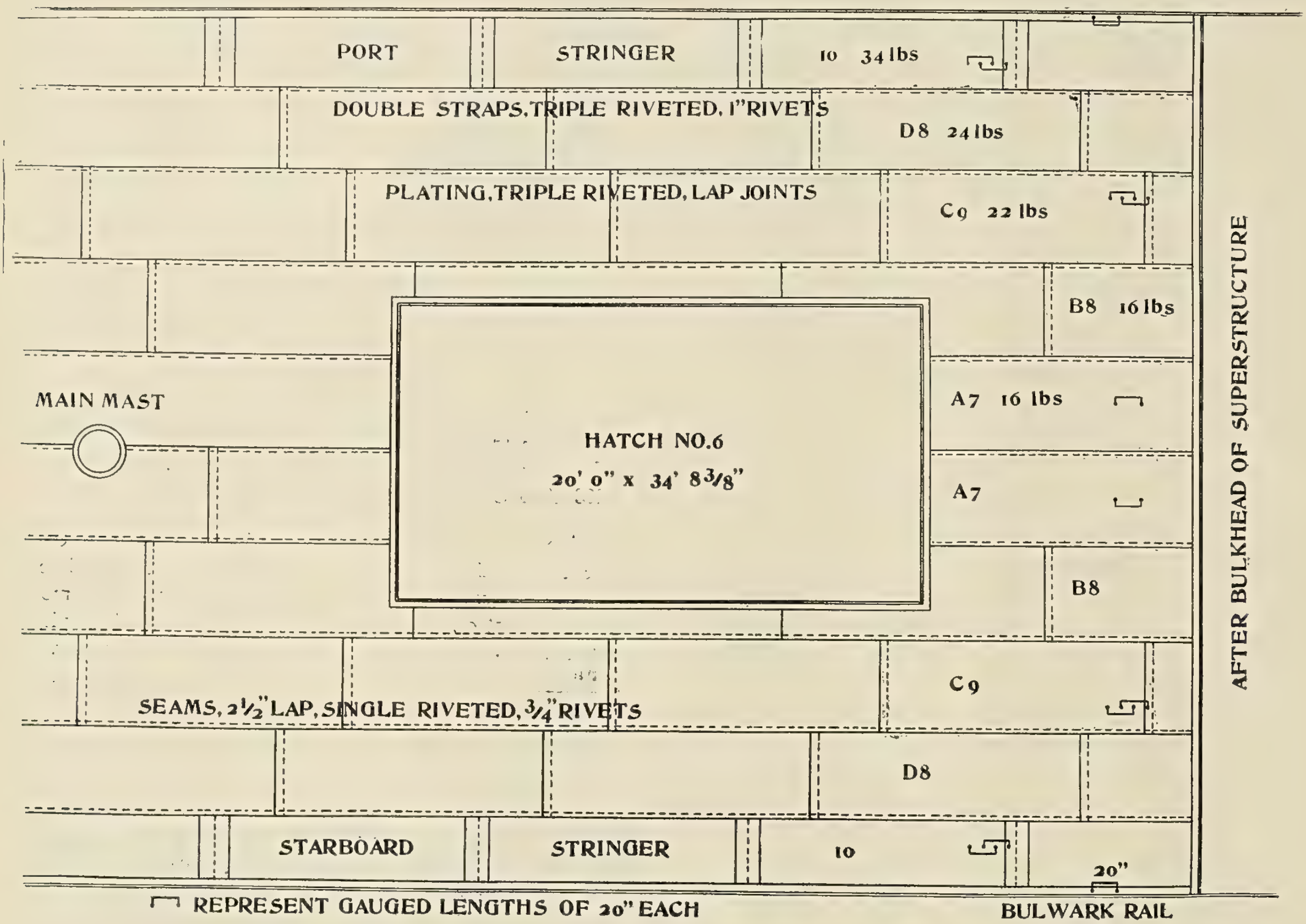


Fig. 10.—Strain Gage Measurements in Plates of Shelter Deck, Made While Receiving Cargo

Brooklyn to Communipaw, and turned half around. Both days were sunny, and it would seem that the effect of the sun on the port side when at Brooklyn was closely reproduced on the starboard side when at Communipaw.

The state of the strains on the mornings of June 16, 19 and 20 were nearly the same. In the meantime, cargo was received which increased the draft from 12 feet 6 inches to 26 feet 6 inches forward, and 19 feet 6 inches to 27 feet 6 inches aft. It is not improbable that some effect resulted from taking this amount of cargo aboard and bringing the ship nearly to an even keel, but the part belonging to temperature effects and that belonging to the cargo does not admit of being separated.

in the lap joints of courses *C* than in the solid plates. Dotted lines on the diagram connect plotted points showing the movements at the joints, located according to the same scale as the plotted strains in the solid plates.

It will be noted, for example, that the changes in strains from June 13 to the 15th on the port side was much greater for the gaged length spanning the lap joint of course *C* than the strains in the solid plate, more than twice as much, while on the stringer course the reverse was true. Here again the general looseness of the lap joints appears in evidence.

Complex thermal conditions prevailed throughout this series of observations, but no more than would be experienced on

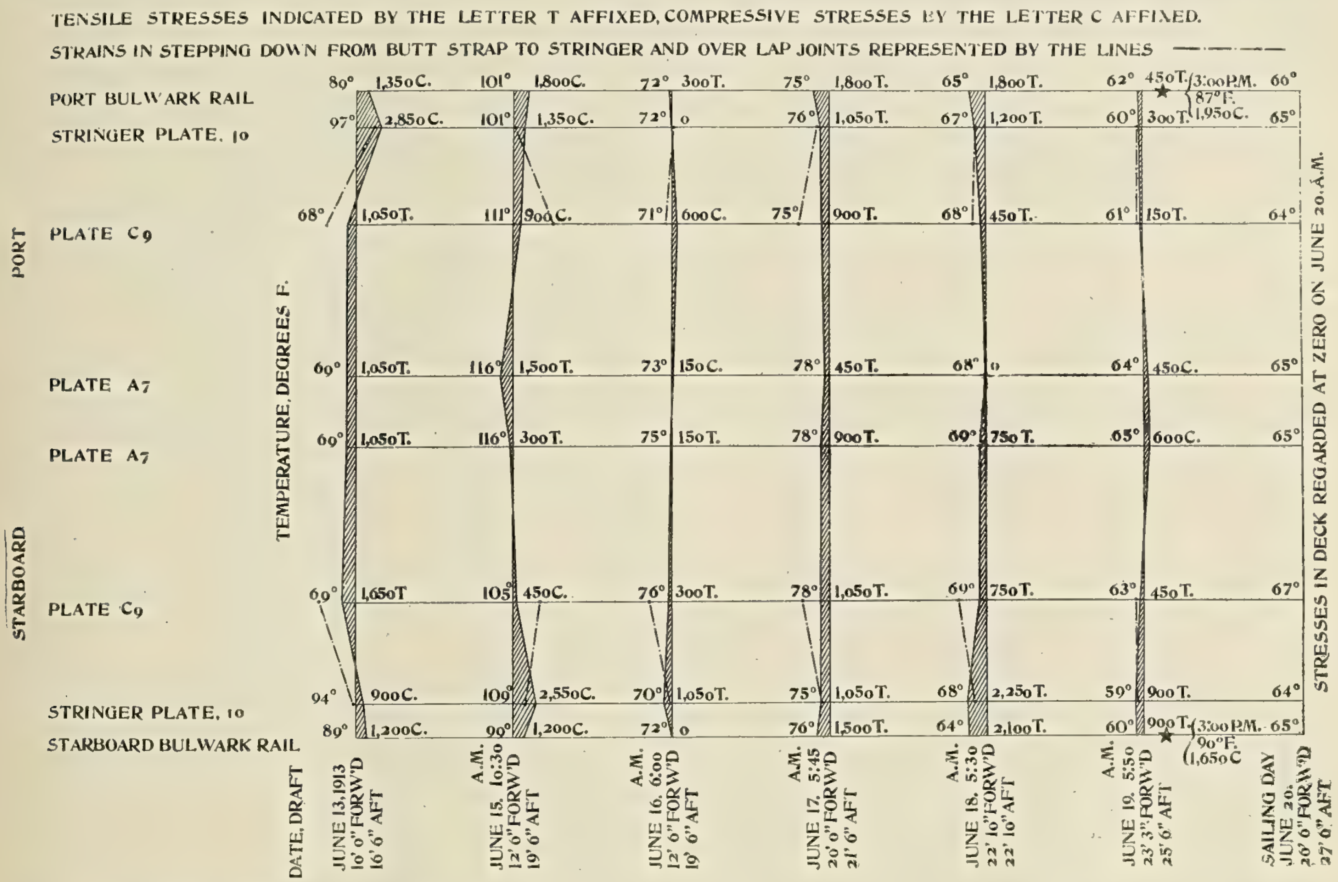


Fig. 11.—Diagram Showing Stresses, Pounds per Square Inch, Corresponding to Strains Measured on Plates of Shelter Decks While Ship Was Receiving Cargo

On June 20 the usual complement of readings was taken in the morning, supplemented by observations on the bulwark rails during the day, the temperature in the meantime having risen from 60 degrees to 90 degrees on the starboard side and 62 degrees to 87 degrees on the port side.

On the starboard side the stress changed from 900 pounds per square inch tension to 1,650 pounds per square inch compression, and on the port side from 450 pounds per square inch tension to 1,950 pounds per square inch compression. These changes again clearly represent temperature effects.

Higher stresses were developed in the more rigid stringer plates and the bulwark rails than in the plates having lap joints, a result to be expected whether caused by temperature changes or by taking aboard the cargo.

The maximum range in stresses observed were 4,800 pounds per square inch on starboard stringer plate No. 10 and 4,050 pounds per square inch on the corresponding port stringer plate. The range in temperature for all places observed was from 60 deprees to 116 degrees F.

Four of the gaged lengths spanned joints in the plating. There was greater apparent rigidity in the butt joints of the stringer courses than in the solid plates, and less rigidity

other occasions. The ship floated in water at about 60 degrees, setting deeper and deeper as the cargo was received, while the temperature of the deck plates reached 116 degrees on one occasion.

In conclusion, attention is invited to the opportunities afforded by engineering structures of all classes in the acquisition of information upon the behavior of materials in service, the distribution of stresses, and verification of computed stresses, along the lines of inquiry illustrated in these strain gage observations.

Shipbuilding Returns.—The Bureau of Navigation reports 101 sailing, steam and unrigged vessels of 15,409 gross tons built in the United States and officially numbered during the month of March. Six of these were steel steamships aggregating 6,435 gross tons. During the nine months ending March 31 eight hundred and eighty-one vessels aggregating 215,059 gross tons were built, of which sixty-nine aggregating 124,275 gross tons were steel steamships. The construction during the corresponding period a year ago amounted to 1,114 vessels of 360,265 gross tons.

Some Questions Relating to Battleship Design*

BY T. G. OWENS

Many and conflicting are the views which are held and have been put forward by experts as to what constitutes the most desirable battleship—*i. e.,* that which embodies the most commendable compromise of conflicting elements to suit the requirements of strategists and tacticians. It may therefore be of interest to outline in one paper the most noteworthy of these views, and to see whether it is at all possible, out of such contradictory elements, to evolve some one proposal which could reasonably be said to embody the desiderata and to eliminate the objectionable features of a battleship with respect to armament, armored protection, speed, dimensions, etc. Such consideration of the subject is perhaps justified, since one feature of the modern line-of-battle ship frequently criticised is the ever-increasing displacement, the normal displacement of some of the most recent types being over 50 percent in excess of that of the Dreadnought of some eight years ago.

Principal Features of Modern Design

The present tendency in warship construction and design, as exemplified in the later ships of all the principal maritime powers, is towards a very large displacement, with the arrangement of all the guns of the primary armament on the center line and with the guns of the auxiliary or secondary armament placed in an armored citadel on, or immediately below, the deck carrying the primary guns; while in respect to the above-water armored protection there is the usual thick armored belt, extending, say, from 4 feet to 6 feet below the waterline to the height of the main deck, and extending over the length of the vessel for such distance as to protect the machinery and boiler compartments, and also the magazines. The armor protecting the primary armament corresponds in thickness in most cases to that of the main waterline belt previously alluded to. The ends of the ship and the citadel or battery for the secondary armament have armor of reduced thickness, approximately half that of the main belt protection. In all the modern battleships there are horizontal protective decks, and in most of the later ships there are also submerged longitudinal protective bulkheads to ward against the effect of submarine explosions, either from torpedoes or mines.

The arrangement of the guns and the distribution of the various thicknesses of armor differ practically with each class of vessels building for each country; but all more or less follow the same general lines, and are designed for the same purposes. It would appear as if matters would go on in this way until either the naval authorities throughout the world convince themselves, or the result of a naval engagement shows, that the thicknesses and the extent of armor as at present fitted are inadequate to afford the protection desired or necessary, or that a reduction in the armored area is permissible without endangering the battle qualities of the vessel; or, on the other hand, that the guns of the primary armaments are larger and more powerful than are called for by the protection given, or that the auxiliary or secondary armament is useless, and could, with its protection, be removed without detriment to the fighting qualities of the vessel. Any one of the above cases, or a combination of them, would, of course, lead to a very considerable reduction in the displacement of vessels, always supposing that the number of guns remained approximately constant, and that the speeds now obtained are considered adequate.

The late Sir William White, in 1911, in a paper to the American Society of Naval Architects and Marine Engineers, stated that the limit of reasonable maximum dimensions had been reached, and that a decrease in the number of primary guns and a retention of the same speed would considerably reduce the size and cost of individual ships. The reduction in the number of primary guns has already taken place, at least in Britain and Germany, but the displacement and cost continue to grow.

It is not easy to formulate a design which one can put forward with confidence as, what has been termed, the most desirable design in every way; but it appears to the author that it is quite possible and reasonable to outline certain conditions which must be fulfilled in order to obtain a ship-of-the-line capable of holding her own in any action where-ever and however fought, and to combine such qualities in a vessel whose displacement would, as present displacements go, be moderate, any increase being solely due to academic or departmental insistance on what may be called "trimmings," not at all necessary to the fighting qualities of the vessel.

Elements of the Most Desirable Design

Primary Guns—Taking first the gun and torpedo armament, it will be agreed that the primary gun and projectile should be of the smallest caliber and weight necessary to carry an efficient bursting charge through the maximum thickness of protecting side armor on a ship of a possible enemy at a range of maximum vision; it should at the same time possess the greatest possible length of danger zone without unduly affecting the life of the gun. Giving all these features due consideration, there appears no great necessity in the present or in the immediate future for guns of larger caliber than 14-inch, which at the range of probable maximum vision, say 12,000 yards, would, according to the Gavre formula, and allowing for angle of descent, pierce the best Krupp armor of a thickness of 14 inches and deliver a heavy bursting charge into the interior of the ship. But guns of larger caliber than 14 inches are already mounted, and a further increase is not outside the bounds of probability.

Arrangement of Primary Guns—As to the arrangement for mounting the guns of the primary armament, it will probably not be disputed that a four-turret center-line arrangement, if carrying sufficient gun power, is, on the score of supervision, smaller target, and smaller number of gun crew required for working, preferable to that of a five or six-turret arrangement; and if such turrets, with their magazines, are separated from each other by a considerable length of ship, the chances are lessened of simultaneous destruction of two complete turrets and magazines by one lucky shot, which, under present conditions, is quite possible.

It may, perhaps, also be agreed that, if all primary guns were arranged to have their axes approximately at the same height above the waterline, the work of those responsible for getting in the largest number of hits in the shortest possible time would be immensely facilitated. This would mean the adoption of a flush-decked ship, the end-on fire would consist of that from the guns of one turret only, which, as end-on fire is now at a discount, would not detract from the value of the ship. The high forecastle would go, the depth molded of the vessel would be increased to give an ample freeboard, and the main deck would then be of sufficient height above the waterline to become the gun-deck for the auxiliary armament.

Auxiliary Armament—As regards auxiliary armament, if secondary guns are to be carried at all, it will be conceded that these should be of as large caliber as can be conveniently man-handled in respect, not only of charging the gun, but in training and elevating it with considerable rapidity. They should be mounted so as to give the highest possible maximum of fire forward and aft, and to possess the largest arcs

*Extracts from a paper read before the Institution of Naval Architects, London, April, 1914.

of training consistent with adequate protection. The height of their axes above the waterline should be such as to enable them to fight in a reasonable seaway, but at the same time this should not be exaggerated, as undue height leads to a large expenditure in weight of structure and armor protection, and to increased target. They should also be as numerous as the conditions of displacement and accommodation will allow.

This arrangement of main and auxiliary armament in its main features accords more or less with that proposed by the late Sir W. H. White in 1910; he wished it placed on record that "in no case is it desirable to carry more than eight heavy guns in a single ship, that these guns are best arranged in four positions, and that they should be supplemented by a powerful and well-protected secondary armament."

Mr. Alan H. Burgoyne, M. P., in his paper read at the last spring meeting of this Institution, suggested that the reversion of the British Admiralty to an anti-torpedo craft armament of 6-inch guns, in their latest ships, was a tacit, if belated, recognition of an error in judgment; certainly no other maritime power followed their lead in dispensing with the secondary guns, least of all those who bore the brunt of the last great naval war, and who knew the merits and demerits of the arrangements placed under their control.

Torpedo-Tubes—The new large-type torpedoes of extraordinary range possess a real as well as moral worth, and in order to utilize such weapons it appears desirable to fit as many broadside submerged tubes as space can be found for within the limits of the dimensions of the ship, and preferably not less than three on each broadside.

Armor Protection—The conclusions arrived at in the preceding part of this paper accord with actual experience and with information gained from reliable sources as to experiments carried out in many countries, and induce the author to put forward as vital:

1. That the waterline area should be protected with armor from a reasonable depth below to a reasonable height above the normal waterline, preferably to the main deck and for the whole length of the vessel, that portion extending along the machinery spaces and magazines to be of such thickness as would probably prevent penetration by projectiles fired from a gun of 14-inch or 15-inch caliber at a range of 10,000 yards, and having the highest practicable initial velocity.

2. That the fixed armor of the barbettes or turrets should be of a thickness not less than that of the waterline belt.

3. That the fronts of the revolving gun-shields for the primary armament should be at least 10 percent thicker than the thickness of the waterline belt.

4. That the conning tower should be protected by armor 20 percent thicker than that of the waterline belt; and

5. That the thickness of the armor protection of the secondary armament should be at least capable of excluding armor-piercing projectiles from the largest man-handled guns of a possible adversary at the decisive fighting range of 8,000 yards.

The late General Cuniberti expressed the opinion in 1912 that battleships should be protected with armor at least 12 inches thick, and, recognizing the practical impossibility of covering the whole side, he suggested that it should more particularly apply to those parts which it is vitally necessary to keep intact until the end of an action.

As to the extent and thickness of armor for the remaining portion of the ship, the main waterline belt should be continued almost to the ends with armor of the same thickness as that protecting the secondary armament, and thence to the ends with armor of not less than 4 inches. Forward of the citadel the vessel should be protected to the height of the main deck, but it was not necessary to carry the armor so high at the after end. The need for increased height of armored end protection forward was established in the last great naval battle; the unarmored forward ends of some of the vessels were completely riddled by quick-firing guns, with the result that the protruding and jagged shell plates coupled with the inrush of water as the vessels tried to steam ahead made the ships practically unmanageable.

Under-Water Protection—The longitudinal protective bulkheads below the waterline protective deck should, if experiments count for anything, be at least 15 feet from the ship's side, and should extend as far as practicable throughout the length of the ship. The construction should be such that that part of the protective deck between the top of such bulkheads and the outer plating will be subject to fracture before the longitudinal protective bulkheads are stressed up to their limits by the confined gases in the outer wing compartments, due to any submarine explosion, but it is difficult to arrange for this in a reliable manner. The distance of the bulkhead from the side of the ship appears to be of more importance than its actual thickness. One experiment carried out showed that a thick bulkhead fitted at the usual distance from the side was broken up by the force of a submarine explosion, and was hurled through the inner bulkheads, destroying the boilers in its course, and more damage resulted apparently than if such bulkhead had not existed.

Proposals have been made to fit under-water broadside protection in such a way as to provide a more or less elastic shield, which would to some extent minimize by its flexibility the effect of the full force of the explosion. Some time ago the author's staff worked out and elaborated a suggestion of Commander Elia for this purpose, and although the arrangement is somewhat expensive, it is apparently more capable of fulfilling the purpose for which it is designed than any other yet proposed.

Internal Subdivision—The question of internal subdivision also assumes a large and important place. The more the internal space both above and below the waterline is subdivided into watertight compartments, the less likelihood is there of the vessel being put out of action either by shell fire or submarine explosion. The views of Professor Hovgaard, recorded in the Transactions of the American Society of Naval Architects and Marine Engineers of 1903, furnish an eminently practical standard for such internal subdivision.

It should also be borne in mind that the same aggregate amount of damage would occur to a small as to a large ship from torpedo attack, and it will readily be seen that an explosion which might possibly put the small ship out of action might leave the large ship capable of maneuvering and continuing in action. As an example of what it is possible to do in the way of meeting such under-water attacks, reference may be made to a foreign warship, designed by the author, and built by Vickers under a contract stipulation that, in the event of 50 feet of the side being blown away amidships, the vessel should not heel over more than 11 degrees, and automatically regain the vertical in a certain specified time, although necessarily with an increased draft due to the buoyancy lost.

Horizontal Protection—Whether the vertical side armor extends to the height of the main or to the upper deck, it is very necessary that horizontal protection of adequate thickness and quality should completely cover it like a lid, extending at least for the full length of the gun citadel, and from armored side to armored side. In the case where the height of the armored side is lower at the ends, the level of the horizontal protection should coincide with it. It is a matter of difficulty to determine with anything like exactitude the correct thickness for such protection. Experiments carried out with plunging shot, with a view to establish some guide in the matter, indicated that it should not be less than 1½ inches of mild steel, or, preferably, of higher quality steel,

possessing the necessary characteristics to act as part of the structure of the vessel, and not purely as horizontal armor involving additional weight—an arrangement sometimes to be found in the ships of foreign navies.

Protective Decks—The above is outside the question of the protective decks proper, either angled or horizontal, in the region of the waterline, or any intermediate deck which may be used for the purpose of protection. The author is rather skeptical as to the value of the angled protective deck, believing that its enormous weight, where it adds least to the structural strength, would be much better employed in thickening the vertical side armor or increasing the horizontal deck forming the armored lid to the side armor. The aim should be to keep out the explosive shell rather than to arrange for its reception in the interior of the ship. The protection afforded by such deck is more apparent than real; but as it will be difficult to convince the men who work below of its weakness, it will probably continue to form a feature of our vessels.

With respect to the value of protective decks, Professor Hovgaard, in his paper of 1903, stated that, while they probably afford the best protection for a given weight against armor-piercing shots, they are far less effective against bursting shells, and that when a high explosive shell bursts against a sloping deck it always results in a great breach. There is every reason to believe that this opinion is correct.

Protection Against Air-Craft—Protection against attack from bombs, etc., dropped from air-craft is not yet in the region of practical politics, and the seaman does not appear as yet to be worried by such danger. When the time arrives to arrange measures to meet such attack they will probably take form in the method advocated by Sir Trevor Dawson—*i. e.*, to increase the thickness, and give a greater curvature, or whale-back formation, to the armored lid before referred to.

Machinery—The principal feature which distinguishes the propelling machinery of battleships of the Dreadnought era from that of an earlier date is the adoption of steam turbines. By their introduction the great advantages of an increase in power per unit of weight was immediately obtained. Thus the new type of machinery simplified the problem of providing for higher speeds with increased displacement due to the armament and protective material. In pre-Dreadnought battleships, powers reaching approximately to about 18,000 indicated horsepower were obtained with a weight of about 1,760 tons, which is equal to 10.2 horsepower per ton of machinery with steam up, whereas in the earliest turbine-driven battleships the power of the machinery was increased to 25,000 shaft horsepower, and 12¼ to 13¾ shaft horsepower was easily obtained per ton of machinery weight.

Twin screws working at comparatively low revolutions gave place to quadruple screws running at a greatly increased speed. Although unfavorable to propeller efficiency, yet the combined efficiency of turbines and propellers, as compared with reciprocating engines and propellers, was such that the former was decidedly favorable to reduction in weight and increase in steam economy. The new type of machinery, being more economical at the higher powers than the reciprocating engines, enabled a reduction to be made in the proportions of the boilers, with a corresponding reduction of weight and of the space occupied.

Respecting radius of action at low speeds, the performance of the earlier types of turbine-driven battleships was somewhat disappointing, but with each successive type improvement was made in this respect. In the earliest ships cruising turbines were installed to drive direct the shafts worked by the main turbines. Later, the cruising turbines were dispensed with and a cruising element was introduced at the forward end of the high-pressure turbine. In the latest designs a separate high-speed turbine driving the high-pressure or low-pressure main turbine line of shafting through gearing seems to find favor and promises most favorably as regards economy at low powers. The fitting of cruising turbines, either geared or direct-driven, involves an increase in the length of the engine room, but the gain which results from the greater economy perhaps justifies this.

As regards type of boiler, there is little to choose between the two generally adopted in British battleships—viz., Babcock and Wilcox and the three-drum straight tube or Yarrow type. The same duty can usually be obtained from either on a given weight or for a given space for a battleship installation. The heating surface, however, is somewhat less for the Babcock and Wilcox type, but in the Yarrow boiler the fire-grate area is smaller. Both appear to be suitable for oil fuel as well as coal, and coal and oil combined can be burned with equal facility, if required, in both.

The exclusive use of oil fuel, as proposed for some recent battleships, effects considerable saving in weight and space for a given power. Moreover, the adoption of oil fuel to the exclusion of coal simplifies the bunkering of the ship, reduces the number of stokers, and enables steam to be maintained with greater ease and for a longer duration of time without cleaning boiler tubes and uptakes. Indeed, oil fuel is altogether desirable from the naval engineer's and naval architect's standpoint. Although the advantages in reduced displacement, higher power, and speed on a given weight, lies entirely in favor of the purely oil-consuming boilers, there is no doubt, in the author's opinion, that, under present conditions as to sources and storage of coal and oil supplies, the safer and wiser policy lies in a combined installation. This would enable a vessel more readily to obtain a constant supply of fuel in war time than would be the case were oil the fuel exclusively used.

The internal combustion engine, although its design and manufacture has rapidly progressed in recent years, has not yet been applied to the propulsion of capital ships. In submarines and in some vessels of the mercantile marine it has undoubtedly proved a great success. The development of the internal combustion engine has now reached a stage at which some engineers are prepared to install these engines in battleships of moderate power and speed. The possibility of failure, with the enormous expense involved, has so far deterred the responsible authorities of maritime powers from arranging for such an installation in large ships, so that for the moment in considering the type ship, such machinery must be omitted. Even in cases where it might be eventually fitted, we are face to face with the fact that, notwithstanding the possible advantages in weight and space to be derived from its adoption, and the undoubted greatly increased radius of action, it would mean a return to the old principle of the reciprocating type with its necessity for balanced movement and compensations, which does not exist with the present system of turbine installations.

Many look with confidence towards utilizing the rotary motion of turbines with some necessary modifications, while dispensing with the present boiler arrangement, by an installation arranged to produce an expansive motive fluid by means of the combination of the products of combustion of small internal combustion units with compressed heated air, such motive fluid being sufficiently cool in order to obviate injury to the turbines. Such an arrangement has already been designed and apparatus of a comparatively large power constructed, on which confidential experiments have been carried out. These point in the direction of ultimate success. Such an installation, while retaining all the advantages of internal combustion machinery with respect to economy of fuel consumption, would at the same time have all the immense advantages of the turbine with its balanced action and unlimited capacity for adapting itself to varying loads. Such

a turbine would not in any sense correspond to what is usually termed a "gas" turbine, nor would it suffer from the drawbacks attendant upon the immense heat which gas turbines are called upon, but fail, to stand. The matter is mentioned here incidentally to show that, even accepting internal combustion engines of sizes suitable for battleship propulsion to be an accomplished fact, the last word has not yet been said.

Finally, in connection with machinery arrangements, the flexibility of the structural portion of long vessels requires some consideration. It apppears very necessary to introduce some device in the form of a flexible coupling in a position between the engine room and the shaft tube, so that the deflections of the ship among waves shall have the minimum effect on the alinement of the shafts.

Designs of the "Most Desirable Ship"

Based on the foregoing conclusions, which go to make up what has been termed "the most desirable ship," there is evolved:

1. Design I, which shows eight 14-inch 45-caliber guns, twin mounted, arranged in widely-spaced barbettes, with the axes of the guns at the same height above the waterline in each case—viz., 27 feet 6 inches.

2. Design II, showing an alternative arrangement, in which eight 14-inch 45-caliber guns are twin-mounted in barbettes. These barbettes, however, are arranged in pairs at each end of the ship, with the axes of the guns placed at different heights above the waterline.

The principal particulars of both ships, in addition to those already stated, are:

Dimensions—580 feet by 91 feet by 27 feet 6 inches draft.

Speed—21½ knots for a continuous trial of 12 hours' duration, burning coal and oil.

Displacement—25,500 tons in the normal condition.

Secondary Armament—Fourteen 6-inch quick-firing guns.

Submerged Torpedo Tubes—Six 21-inch broadside.

Armor—The main waterline belt is of 13-inch K.C. armor, reduced to 6-inch and 4-inch at the ends. The fixed armor of the barbettes, where unprotected by other armor, is of K.C. quality, and equal in thickness to the main waterline belt. The front portion of the gun-shields is 14 inches in thickness. The secondary armament is in each case protected by K.C. armor not less than 6 inches thick. The conning-tower armor is 16 inches thick, of K.C. quality. Below the main waterline belt 3-inch K.C. armor 30 inches deep has been worked.

Machinery—Parsons' geared turbines on four shafts, with cruising turbines on each shaft.

Boilers—The boilers are of large watertube type, arranged for moderately high air pressure.

It will be seen that the vessel shown by Design I is in every way equal to the vessel shown in Design II with the exception of the end-on fire, and, in addition, has the various advantages already stated as to distribution of turrets; but, as custom is very strong, it is probable that the arrangement shown in Design II will more or less continue to prevail. It will probably be contended that the features outlined in Designs I and II exist more or less in present ships either built or building; in such case this is, in the author's opinion, so much the better for the ships, seeing that the deductions in the paper have been made not directly from what actually exists in present ships, but from what, if the arguments are correct, should exist to meet present conditions. The everyday experience of a warship designer brings him so much in contact with foreign authorities in discussing characteristics and details of warship construction that the author cannot conclude a paper like this without bearing testimony to the immense amount of skill, foresight, and common sense brought to bear in the evolving of designs, or in drafting the conditions to be met by designers, and to the real extent of which progress in warship design, as a whole, is furthered by experts of other countries than England. As a passing example, it may be mentioned that at the time when the main-drainage arrangements in British ships consisted of one or more continuous longitudinal drains practically connecting up each large compartment in the ship, many foreign vessels had each main watertight compartment quite independent in such respect. The same applies to the method of ventilation, both of which systems have since been adopted in this country. This point is merely given to show that, notwithstanding the great extent to which all maritime countries benefit by every advance made in British naval construction, we also receive valuable suggestions from those countries for whom we build, and also from those who build exclusively for themselves.

The author desires, in concluding, to express thanks to Sir Trevor Dawson for some of the later information respecting artillery; to Mr. McKechnie, in connection with the part referring to steam machinery; and to the author's staff for their assistance generally. He further wishes to acknowledge his obligation to various authorities and sources, whether mentioned in the paper or not, for much valuable information.

The Rational Non-Diesel Marine Oil Engine

BY ALBERT H. ZIEGLER

Although America may be justly proud of the high degree of engineering skill and the effective manufacturing methods displayed in the production of very large gasoline (petrol) marine engines, nevertheless it must be admitted that in the production of large marine oil engines America has long ago been fairly outstripped by most of the European countries. The internal combustion marine engine industry is realizing the fact that further material development and important extension of the field of application for its product, especially in the larger deep sea-going craft in competition with modern steam machinery, is not to be hoped for until the industry has settled definitely upon some one all round commercially practical system of fuel utilization which will promote the successful combustion of the very heaviest and cheapest of residue and refuse fuel oils instead of gasoline (petrol).

The oil engine itself is of course by no means a new subject for investigation and experiment to American manufacturers, many of whom have spent considerable money in making very earnest and consistent attempts at the solution of its problems ever since the very outset of the internal combustion engine industry. Until recently, however, not only have the ultimate attainments in American oil engine development been in no wise particularly notable or successful, but in only two or three instances where American builders have bought the patent rights from European interests have their products proved even moderate commercial successes.

The main reason for this has been that nearly all American manufacturers have for conservative business reasons refused to accept the Diesel oil engine as the only way out. They have chosen to experiment with slightly modified units of their regularly manufactured and marketed gasoline (petrol) burning engines. Indeed, they have shown an unmistakable gasoline (petrol) engine bias and have sacrificed too readily some of the most important theoretical functions of correct internal combustion engine design for the sake of obtaining some detail result of minor importance.

The non-Diesel oil engine may be defined as an internal combustion engine which takes oil fuel into the working cylinder during the suction stroke along with the air charge, atomizing and gasefying the oil during the suction and compression strokes in which the compression pressure attained

is less to any desired degree than that required in the purely Diesel engine, though not less than is common in the ordinary well-known types of gasoline (petrol) engines, which employ mechanically-timed and controlled electric ignition.

Even the most modern forms of Diesel engines, whether of the two or the four-cycle type, are constitutionally large, heavy, complicated, and very costly in comparison with a non-Diesel oil engine. They require a great many expensive auxiliaries and accessories new to the marine engine trade, such as high-pressure compound intercooled air compressors from which air at about 1,000 pounds pressure is pumped into heavy drawn steel tanks or bottles for use in fuel injection or atomization and for starting the engine. There are also required governor-controlled variable-stroke high-pressure fuel pumps, usually one to each working cylinder, fuel injection timing mechanisms for the delivery of the high-pressure oil and air to the workinng cylinders, delicate and easily-clogged fuel injecting and atomizing valves, one in each working cylinder, involving considerable complex high-pressure piping, and several pressure gages. In addition to the difficulties of design and high cost of construction and maintenance involved in the purely Diesel type engine, the eternal vigilance required by the operating engineers to insure continuous and reliable operation of so much high-pressure equipment can be fully appreciated only by those who have had such problems to solve and deal with.

In some of the multi-cylinder two-cycle Diesel marine engines, there is also the further complication of a large double-acting scavenging air pump, usually located on the forward end of the engine. This large low-pressure air compressor involves an extra crank and, therefore, an appreciably longer and more expensive engine crank shaft, a crosshead with guides, a piston rod and stuffing box, two multiplex nests of large area, intake and discharge disk valves, and a low-pressure air receiver. In other two-cycle Diesel engines, the pistons in each of the working cylinders are of the two-diameter or differential type, the lower or large end acting as a low-pressure scavenging pump for its respective working cylinder, thus involving a higher and heavier engine, bulky cylinder castings and a double diameter of cylinder bore and multiplex nests of intake and discharge valves.

Besides the weight, bulk and cost of such complications there is always in the Diesel engine the liability of at least temporary inability to operate, due to defects, wear and small changes of adjustment of any of the detail parts of such mechanisms. Although the Diesel engine has no need of a carbureter, the multiple pumps, injectors and atomizers, high-pressure piping, air bottles, gages, etc., are a vastly more complicated and costly substitute. In the past Diesel engine builders have boasted that their engines needed no electric or other forms of ignition appliances, but now some of the more advanced investigators are recommending the incorporation of electric ignition apparatus in the designs in order to synchronize and time more accurately the ignition point in all cylinders to eliminate the dangers due to destructive premature ignitions and to insure positive ignition in case of excessive leakage and loss of compression resulting from wear, breakage or gumming up of the valves, pistons or piston rings.

In spite of the fact that the fuel consumption per brake horsepower hour in Diesel engines is remarkably low (when everything is operating properly) and that the available fuels are remarkably cheap and plentiful, there are other considerations involved which may more than offset these apparent economies. The principal consideration is the high first cost of the engine, and the cost of repair and upkeep. As compared with a non-Diesel oil engine installation, there is an increased expense of a larger operating crew, together with their necessary quarters, and above all there is the heavy overhead cost due to possible necessity of laying up the ship for cleaning, repairs and readjustment of any derangement of the machinery, which might come about through the shortcomings of the operating crew, and their lack of sufficient understanding of the principles of operation of such engines and their accessories. Moreover, the ability of the Diesel engine to burn any and all kinds of fuel oil continuously and reliably is for the present at least much overrated. The writer has seen chunks of carbon, practically coke, larger than a man's fist, taken out of the combustion spaces of Diesel engines operating on paraffin base oils of lighter weight and density than 28 degrees Baumé. This occurred simply because the problem of perfect oil atomization in the engine cylinder is if anything even greater in the Diesel engine than in the lower-compression non-Diesel type. With all the infinite care evidenced in the design and construction of the Diesel fuel injectors and atomizers, the oil is seldom completely atomized. The first and last drops of each fuel charge are especially liable to enter the engine cylinder in a liquefied form, and any engine, whether of the Diesel or other type, which permits oil fuel to enter the cylinder in liquid form will "crack" such oil, gasifying the lighter hydrocarbons which it contains and baking the remainder into hard gritty carbon which accumulates until the engine becomes inoperative. It is absolutely imperative for efficiency, continuous and reliable operation that all oil to the last atom be so finely subdivided or atomized upon its admission to the engine cylinder that even without the application of the heat of compression the cloud of vapor thus produced will remain suspended in the air charge for several minutes.

Instead of its many significant faults and drawbacks, the Diesel engine as a prototype of what the future will undoubtedly produce, has given abundant evidence of the latent possibilities of the internal combustion engine, and has fully warranted further experiment. The excessive cost of experimenting with that form of engine, however, which must be paid by each and every concern that attempts such construction, compared with that found necessary in the development of gas and gasoline (petrol) engines, has very naturally scared off the very conservative American engine builders from research along Diesel engine lines. Although anxious to keep step with Europe in the matter of the number and size of deep sea oil engine installations actually made, nevertheless, to interest American manufacturers at all, the forthcoming American product will have to involve less cost of experiment and research, less weight, size, bulk and complication, require a less scholarly prepartion on the part of engineers, be more easily and cheaply designed and constructed, and, in short, constitute itself more of a commercially practical proposition than has been the case thus far with the orthodox Diesel engine.

In the search for such a production, most American builders have in turn experimented with, developed and finally rejected several distinct methods of oil combustion with almost infinite variations and modifications of detail. Practically all of these experiments have aimed to utilize with as little change as possible the builders' stock models of gas and gasoline (petrol) engines. Some have attempted to pass the oil fuel through the more or less regular gasoline (petrol) carburetor, either hot water jacketing the outside of the bowl, the passage surrounding the nozzle, the inlet pipe from the carburetor to the engine inlet valves, or all of these. Also separately or in conjunction with this water jacketing, they have taken the incoming air from a heater sleeve, surrounding the exhaust pipe, and in some cases have placed an exhaust heated radiator or nest of tubes within some portion of the inlet pipe. Very few of these, however, made any serious attempt at a nozzle which would efficiently blow the fuel into veritable atoms, though many incorporated various screens, fans, helices and other devices over the nozzles with the intention of breaking up the spurt of fuel. Practically all

of these, however, serve only to set up excessive fluid friction and a high vacuum in the intake pipes, causing unnecessary loss of engine efficiency and power output.

Although such carburetors when equipped with properly-regulated automatic air valves produce very good results when operating on heavy gasoline (petrol) and the lighter kerosenes (paraffines), nevertheless as the oils used through them become heavier their degree of successful operation rapidly drops. With fuels no heavier than "Solar" oil and "gas" oil they become commercially impossible. The engines lose all flexibility of speed and power control, the exhaust proves extremely sooty, the pistons, piston rings, valves and igniters become rapidly tarred and gummed up, the piston spaces are thickly carbonized, self and pre-ignition becomes so troublesome that the compression pressure must be reduced to a most uneconomical point and the consumption of fuel per brake horsepower hour is about double of what the consumption of gasoline (petrol) would be in the same engine. The power output is considerably less, and finally after from ten to fifteen hours' operation the engine becomes inoperative, requiring a thorough cleaning.

The carburetor method, though commercially practical with gasoline (petrol) and the lighter kerosenes (paraffines), can offer very little hope for the future on heavier oil fuels; for, though it may be possible to so design the nozzles as to atomize sufficiently the fuel charges passing through them, the succeeding length of inlet pipe to the engine valves with its several necessary bends and elbows will assuredly condense or reliquefy on the walls of such passages sufficient oil fuel to make the fouling of the combustion chambers apparently certain. However extensive the hot water jacketting and however carefully the exhaust heated portions of such a carburetor may have been designed and placed, it is practically impossible to so control automatically the applied heating effect of such appliances under all the wide variations of load and speed as to make it always just sufficient to gasify even a properly-atomized oil spray. Either this heat will at times prove sufficient to "crack" the oil into its lighter and its heavier components, the heavy portions being thrown down on the walls of both the inlet passages and the combustion chambers, or it will prove so low as to permit reliquefaction on these walls. Both of these conditions cause fouling, non-reliable operation, high fuel consumption, and a low power output.

As the main idea of oil engine research is to make available in the engine cylinder the cheaper and more abundant distillations from crude petroleum in the place of the very satisfactory though very limited available supply of light and heavy gasoline (petrol) and the lighter kerosenes (paraffines), the so-called carburetor type of oil engine, because of its restriction to the lighter distillates only, holds little promise for the future. Such lighter hydrocarbon distillates from crude petroleum constitute not over 10 percent of volume of the crude oil as taken from the ground. The market cost of the gasoline (petrol) and kerosene (paraffin) distillations, in the absence of a material market for the other 90 percent, must of course cover the entire cost of production, refining, handling and marketing of all the raw product, minus what may be received for the heavier by-products, which at present is comparatively little. Should the production of a successful type of heavy oil engine be accomplished, the market value of the lighter petroleum distillations would drop very considerably and the price of the heavier distillations would rise slightly, tending to equalize the price on all by-products and making an enormous increase of internal combustion engine fuels available at a reasonable price. This no doubt would result in a widespread growth of all branches of the internal combustion engine industry and make possible marine engines for the largest of the sea-going ships.

(*To be continued.*)

Further Experiments Upon Wake and Thrust Deduction*

BY W. J. LUKE

The following notes on wake and thrust deduction are supplementary to the paper on the same subject presented to this Institution in 1910. At that time the modifications in the hull-efficiency elements of a model, 204 inches long, 30 inches wide, 9 inches in draft, and of 0.65 block coefficient, due to certain variations of linear speed, propeller diameter, pitch ratio, area ratio, etc., formed the subject matter. Briefly stated, the results then presented show that increase in speed caused a slight decrease in wake and hull efficiency, but that the variation was of little moment. A considerable decrease in wake and increase in thrust deduction followed increase in diameter in single-screw experiments. The hull efficiencies with the larger screws were thus substantially less than those with the smaller.

In twin-screw experiments, with the centers of shafts in a standard position, the larger the screws were the greater became the wake and hull efficiencies when outward turning. When inward turning, the wake values were modified only slightly with increase in diameter, but a steady increase in thrust deduction gives a much lower hull efficiency value with the larger diameter screws. It was shown by the experiments with various transverse positions of the screws that the closer these were placed to the hull the higher became the wake and hull efficiency values. Experiments dealing with fore-and-aft position indicated that the further aft the screws were placed the less became the wake and thrust deduction values. Decrease in the value of the hull efficiency elements accompanied decrease in pitch ratio, and neither area nor number of blades had any appreciable effect on wake and thrust deduction.

The most important point disclosed by the results then presented was the great effect of direction of rotation when the angles of shaft bossings were extreme—*i. e.*, when horizontal or vertical. With the standard screws a wake fraction of only 0.10 was obtained when revolving inwards behind horizontal bossings, while this was increased to 0.32 when outward turning, the hull efficiency value obtained in the former case being 0.94, while 1.10 was recorded in the latter. The resistance of the bossing itself increased with the angle of inclination either way from the normal—that is, it was least when at an angle normal to the line of the shell, and greater when horizontal or vertical. The additional hull efficiency gained with the proper direction of rotation, when extreme angles such as the horizontal or vertical were adopted, almost compensated for the greater resistance of the bossing. Apart, however, from this consideration, the results indicated the possibility of committing a gross error by the adoption of inward-turning screws with horizontal bossings, in which bossings causing great resistance would be associated with low hull-efficiency values.

During the discussion that followed the reading of the paper referred to, Professor Welch asked whether the investigations had been extended to cases of screws having a common axis, one screw being placed behind the other, such as the contrary-turning screws of locomotive torpedoes. At that time apparatus for experiments in this direction had been prepared, but no substantial series of results had then been obtained. The purpose of the present communication is to give the results of experiments with contrary-turning screws on a common axis; of experiments with tandem screws, and also of experiments with quadruple screws.

Lieutenant-Colonel Rota, in his paper, "The Propulsion of Ships by Means of Contrary-Turning Screws on a Common

* From a paper read before the Institution of Naval Architects, London, April, 1914.

Axis," delivered to this Institution in 1909, drew attention to the success attending the adoption of that system in a 46-foot steamboat of 25 tons displacement. The results communicated showed an advantage in the adoption of contrary-turning screws of about 25 percent over the performance of a single screw of larger diameter. The author suggested this to be due in the main to two causes, viz., increase in hull efficiency through increased wake and decreased thrust deduction, and increase in propeller efficiency. With this information and previous experimental work in view, the present experiments were directed towards ascertaining what efficiency would be exhibited by contrary-turning screws on a common axis (hereafter designated "combination" screws) apart from the introduction of the hull-efficiency elements; and further, what influence was exerted by these latter factors. It was considered that "open" and "behind" experiments, such as are usual when undertaking wake investigations, would give the necessary information to enable a judgment to be formed as to wherein lay the virtue of the "combination" screws. Records of thrusts, torques, revolutions, and speed of advance were obtained with various combinations of screws, when working in the "open" and also behind models. Two models were brought into requisition, one being that on which the investigations already brought before your notice were made, the other being of almost similar dimensions. but of finer block coefficient.

PARTICULARS OF MODELS.
(Dimensions in Inches.)

	Length.	Breadth.	Draft.	Block Coefficient.	Displacement in Pounds in Fresh Water.
Full model....	204	30	9	0.65	1296
Fine model....	200	30	9	0.60	1175

The standard propeller chosen was that adopted in the former experiments—namely, of 6 inches diameter—having three blades, 1.2 pitch ratio, and 0.375 disk area ratio.

Experiments were made first with a single standard screw, and its performance was noted when revolving "behind" the full model when advancing at a speed of 332 feet per minute (corresponding to a speed of 16 knots for a 400-foot ship), and in the open at a speed of 280 feet per minute (estimated to be a suitable speed allowing for wake). With the combination system experiments were made with the standard screw in conjunction with each of three others identical with the standard in all particulars except pitch ratio, of which the three values used were 0.8, 1.2, and 1.6, the standard screw leading in each case. Were there any inherent virtue in the "combination" screws apart from that accruing from their interaction with the model, it would be apparent in efficiency when running in the open. It was found that the two propellers of 1.2 pitch ratio in combination gave a thrust which was approximately twice that obtained by the single screw; the torque, however, was perceptibly greater than twice that required to drive the single screw.

With an ordinary twin-screw arrangement the thrust obtained equals twice that of one screw, and the propeller efficiencies are identical. The open efficiency of the "combination" screws at the point of self-propulsion was found to be about 0.86 of those of the ordinary twin-screw. The results obtained from the experiments behind the full model (when investigating wake and thrust deduction values) were so remarkable that the experiments with the two standard "combination" screws were repeated three times. Wake experiments had previously been made with the ordinary twin-screw arrangement, and also with the single screw (as described in the previous communication), and the results obtained were as follows:

	Wake.	Thrust Deductions.	Hull Efficiency.
Twin screws	0.20	0.15	1.02
Single screws	0.34	0.17	1.11

With the "combination" screws the wake was discovered to be greatly in excess of that obtained by the single screw, while the thrust deduction was very little different; accordingly the hull efficiency showed a considerable increase. The results of the four separate sets of experiments with the two standard screws are as follows:

	Wake.	Thrust Deductions.	Hull Efficiency.
1.	0.57	0.17	1.31
2.	0.61	0.17	1.34
3.	0.61	0.17	1.34
4.	0.64	0.19	1.33

Experiments with the 1.2 and 0.8 pitch ratio screws in combination, and with the 1.2 and 1.6 pitch ratio, confirmed the results obtained with the standard screws. Together with the average value of the four cases above, they stand thus:

Pitch Ratios.	Wake.	Thrust Deduction.	Hull Efficiency.
1.2 and 0.8	0.59	0.19	1.27
1.2 " 1.2	0.61	0.17	1.34
1.2 " 1.6	0.57	0.19	1.27

The efficiencies of the screw when working both in the "open" and "behind" were observed, and no appreciable difference was evident in the rotative efficiencies. Because of the great increase in the hull-efficiency values, the "combination" screws show a considerable gain in propulsive efficiency over the ordinary twin-screw arrangement. In the latter case, the propeller efficiency at the point of self-propulsion was 0.56, and the hull efficiency 1.02. Thus propeller efficiency $\times$ hull efficiency $= 0.57$. With the "combination" arrangement the propeller efficiency at the point of self-propulsion was 0.49, and the hull efficiency 1.34, giving $0.49 \times 1.34 = 0.66$, as compared with 0.57 in the ordinary twin arrangement. The above results are for the full model.

Four years elapsed between the experiments with the full and fine models. The relative efficiencies of the single screw and the "combination" screws were again put to test, and the former experiments were verified, in that the open experiments showed the efficiency of the "combination" arrangement to be 0.86 that of the single screw, and accordingly also that of the ordinary twin screws. With the finer model, when advancing at a speed of 372 feet per minute (corresponding to a speed of 18 knots for a 400-foot ship), the same peculiarities as to high wakes and hull efficiencies with the "combination" screws, as with the fuller form, are evident, but they are not so much accentuated. With the single screw and the ordinary twin arrangements, the results obtained were as follows:

	Wake.	Thrust Deductions.	Hull Efficiency.
Single	0.22	0.16	1.02
Twin	0.13	0.13	0.98

The same combinations of contrary-turning screws were run as with the full model, with the following results:

Pitch Ratios.	Wake.	Thrust Deduction.	Hull Efficiency.
1.2 and 0.8	0.29	0.12	1.14
1.2 " 1.2	0.33	0.12	1.17
1.2 " 1.6	0.33	0.12	1.17

The gain in this case is not nearly so great as with the full model.

The open experiments show that, apart from wake effect, the system is not as good as a twin-screw arrangement. With a full-ended model, as used in the first experiments, the wake is such that the combination screws are able to make sufficient use of it to nullify the loss in open efficiency, and to show a net gain of 15 percent. In this fine model, however, the wake is diminished so that the gain possible in hull efficiency just about balances the open efficiency loss, and the gross return, propeller efficiency $\times$ hull efficiency, practically equals that of the twin-screw arrangement.

The results obtained by the "combination" screws when behind were so remarkable that it was thought that tandem

propellers might also show peculiar propensities. Previous experiments undertaken at Clydebank had shown what had also been discovered by Professor Durand, that in the open tandem screws did not give a thrust equal to that of twin screws of the same dimensions. On placing upon a single shaft two similar screws placed two-thirds of a diameter apart or more under the same circumstances of revolution and slip, the thrust was found to be only about 10 percent greater than when one of the two screws was removed; the efficiency of the system was also found to be low.

Experiments with tandem screws in the open and when behind the finer model were carried out; the screws used in these experiments were in case (*a*) two of 1.2 P.R., and in case (*b*) of 1.2 P.R. and 1.6 P.R. The 1.2 P.R. screw was leading in both cases, and the propellers were placed quite close to each other, just as they were in the combination experiments. From the results obtained the former conclusion that tandem propellers have little or nothing to recommend them was amply confirmed. In the open the thrusts obtained are low compared either with a twin or combination arrangement. The open efficiency of the latter is not great, but the hull efficiency elements associated with "combination" screws are high. The tandem screws have no such effect on wake and thrust deduction, and the hull efficiency values obtained were not abnormal, as the following figures show:

Pitch Ratios.	Wake.	Thrust Deduction.	Hull Efficiency.
1.2 and 1.2	0.26	0.20	1.01
1.2 " 1.6	0.24	0.16	1.04

The hull efficiency values are thus about 15 percent less than those obtained with the contrary-turning screws, with the same combination of pitches.

Taking the hull efficiencies in conjunction with the propeller efficiencies at the point of self-propulsion, the following figures are obtained for the fine model:

TANDEM SCREWS.

Pitch Ratios.	Hull Efficiency.	Propeller Efficiency (at point of self-propulsion).	Hull Efficiency × Propeller Efficiency.
1.2 and 1.2	1.01	0.50	0.50
1.2 " 1.6	1.04	0.44	0.46

These compare with the undernoted corresponding figures for the "combination" arrangement:

Pitch Ratios.	Hull Efficiency.	Propeller Efficiency (at point of self-propulsion).	Hull Efficiency × Propeller Efficiency.
1.2 and 1.2	1.17	0.58	0.68
1.2 " 1.6	1.17	0.52	0.61

It will be observed that the propeller efficiencies of the "combination" screws at the point of self-propulsion are (in this case) considerably greater than those of the tandem arrangement. This is accounted for by the fact that to reach the point of self-propulsion the propellers were working at a high real slip, and that the combination screws gave the required thrust with fewer revolutions than did the tandems, and at higher points in the efficiency curves. If the tables giving the comparative open efficiencies of the combination and tandem screws be examined (given in the Appendix) it will be seen that, although at moderate slips the tandem screws are the more efficient, at the higher slips this superiority disappears. At the real slip requisite to overcome the resistance of this particular model, the efficiencies of all the combinations of the contrary-turning screws are considerably in excess of those of the tandems.

To sum up this question, it appears that the "combination" screws have not a little to recommend them, and, were the engineering difficulties connected with their application to marine propulsion overcome, they would be well worthy of consideration. Tandem screws have nothing to recommend them.

With the introduction of triple and quadruple screws for the propulsion of ships arose the necessity for modifying the existing experimental apparatus so as to be able to undertake wake and thrust deduction experiments on models of vessels with more than two shafts. Before these modifications were introduced the experiments with the forward and after screws were made separately just as if each set were a pair of twin screws; the condition taken for analysis of each pair being that the thrust equals half the resistance of the model with no screws working behind plus the augment caused by these screws. The aggregate thrusts of the forward and after screws thus equal the total augmented resistance. This assumes complete non-interference. This latter was a doubtful point and it was resolved to undertake experiments in the first place, as for twin screws, and afterwards to observe the effect on the performance of the forward screws of a pair of revolving but non-recording screws placed in the after position, and also on the after screws of a pair placed in the forward position; these non-recording screws were placed on a fixed frame, and could be given any desired rotary speed.

The results given apply only to the fine model. Three-bladed propellers, 4 inches in diameter, of 1 pitch ratio and of 0.6 disk area ratio, were used in these experiments. The inner propellers were placed just forward of the after perpendicular, with the tips reasonably clear of the hull; the outer propellers were placed so that in projection their disks just touched the disks of the inner screws. The outer screws were carried as far forward as the form of the ship would allow, giving the same clearance from the hull as obtained in the after pair.

The results of the twin-screw experiments call for no special comment except that the high hull efficiencies obtained are due probably to the close proximity of relatively small propellers to the hull of a very wide model.

From these results the action of the forward screws has a material influence on the wake of those in the after position, and the hull efficiency of these screws is considerably reduced. The suction of the after screws reduces very slightly the wake proper to the forward screws, and the hull efficiency elements remain practically the same as in the twin-screw experiments. Broadly speaking, the wakes of the after screws were reduced on the average by 0.07, and those of the forward screws by 0.01. Some light upon two most important points in connection with the propulsion of vessels by quadruple screws is obtained from these experiments. In the first place, the wake value to use in propeller design is approximated to, and, in the second place, the combination of directions of rotation to ensure the highest gross hull efficiency can be obtained. The various combinations possible are:

(*a*) After screws, outward turning; forward screws, outward turning.

(*b*) After screws, outward turning; forward screws, inward turning.

(*c*) After screws, inward turning; forward screws, outward turning.

(*d*) After screws, inward turning; forward screws, inward turning.

With this particular model the gross hull efficiency values obtained with these various combinations are almost identical, although it is not possible to say that this is a general rule. The experimental conclusions may at least be some guide in the analysis of trial results, which analytical conclusions will form the basis for design in future cases.

The Design of Merchant Ship Forms*

BY PETER DOIG

Load Waterline Shape

For the determination of load waterline half-breadths Table V has been prepared. The values were found by dividing the waterline breadths (in terms of the extreme breadth) by the area coefficients at the respective stations as given in Tables II, III and IV. These ratios give contours of waterline, ensuring good forms for propulsion while conforming to the other important elements in a good design. The procedure in designing the lines of a ship is somewhat as follows:

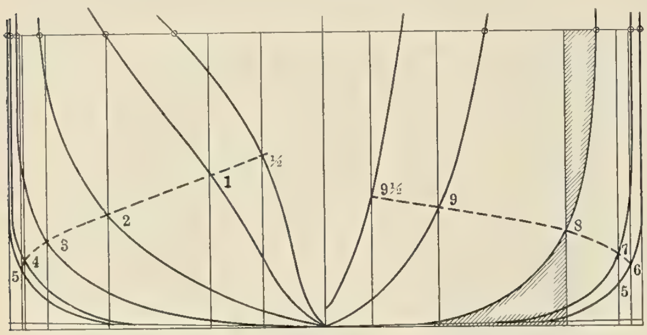


Fig. 2

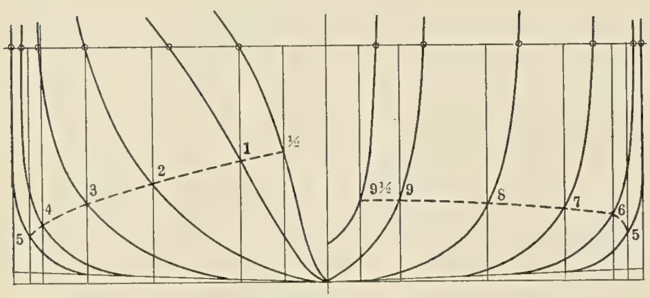


Fig. 3

When (1) length, (2) breadth, (3) draft, (4) displacement, and (5) longitudinal position of center of buoyancy are known, a curve of transverse sectional areas is constructed to these requirements. The beam, draft and rise of floor lines are drawn on a suitable scale as the foundation of the proposed body plan. To obtain sections of the required areas, rectangles bounded by the waterline, center line, base and a line from the waterline to the base are laid off (Fig. 2). The outlines of the transverse sections are drawn so that the parts inside and outside the bounding line, as marked in the figure, are equal, thus producing the areas required.

These are in substance the necessary steps in designing forms by the use of the tables appended. Fig. 2 represents the lines of a freight and passenger steamer of the subjoined particulars:

Length, 500 feet.
Breadth, 63 feet.
Draft, 29 feet 6 inches.
Displacement, 18,400 tons.
L. C. B., 1.5 feet forward or 0.3 percent of length.

This gives a block coefficient of .692, which with a mid-area coefficient of .960 corresponds to a prismatic coefficient of .721. From Tables II and III the area coefficients are obtained by linear interpolation, as in the first column below. The figures in the second column, from Table V, are multipliers to be applied to these area coefficients, giving the waterline coefficients, or breadth at station ÷ extreme breadth, in column 3. The last column gives, by multiplication of the values in the first by the mid-area coefficient (C_m = .960) the mean breadths of the sections in terms of the ship's half breadth amidships:

Station	1	2	3	4
0	0	...	0	0
½	.199	2.32	.462	.191
1	.380	1.82	.692	.365
2	.717	1.26	.904	.688
3	.919	1.05	.965	.882
4	.998	1.00	.998	.958
5	1.000	1.00	1.000	.960
6	1.000	1.00	1.000	.960
7	.964	1.01	.974	.926
8	.793	1.09	.866	.762
9	.374	1.36	.509	.359
9½	.150	1.61	.242	.144
10	0	...	0	0

The widths of the load waterline and of the rectangles of equivalent sectional area are figured from the last two lines of above table and laid off to scale (Fig. 2).

To obtain an approximately "fair" body plan the locus of the crossing points of the sectional outlines and the sides of the rectangles is kept in as gradual and sweet a curve as possible. When this has been done the resulting plan will be ready for final fairing in the usual drawing-office manner. Fig 3 represents the form of a transatlantic liner 750 feet by 85 feet by 32 feet draft, of 34,300 tons displacement, and a position of center of buoyancy 6.0 feet aft of amidships.

The body plan of Fig. 4 is that of a slow freighter 420 feet by 56 feet by 28 feet 6 inches draft, 15,450 tons displacement and a center of buoyancy 2.0 feet forward of the center between perpendiculars.

Metacentric Height Tables

In the preliminary stages of a design it is necessary to fix quickly the beam requisite for the desired "G M." The height

Table V.

Prismatic Coefficient.	Station.										
	½	1	2	3	4	5	6	7	8	9	9½
.52	2.19	2.09	1.78	1.36	1.11	1.00	1.06	1.20	1.37	1.56	1.68
.54	2.09	2.01	1.68	1.31	1.09	1.00	1.05	1.17	1.32	1.49	1.60
.56	2.01	1.93	1.59	1.25	1.07	1.00	1.04	1.14	1.26	1.42	1.54
.58	1.95	1.84	1.49	1.20	1.05	1.00	1.03	1.11	1.21	1.36	1.47
.60	1.91	1.77	1.41	1.16	1.03	1.00	1.02	1.09	1.16	1.30	1.42
.62	1.90	1.71	1.33	1.13	1.02	1.00	1.02	1.07	1.13	1.25	1.40
.64	1.93	1.70	1.30	1.11	1.02	1.00	1.01	1.05	1.12	1.24	1.41
.66	2.03	1.74	1.28	1.09	1.01	1.00	1.01	1.04	1.11	1.26	1.44
.68	2.19	1.82	1.28	1.08	1.01	1.00	1.01	1.03	1.11	1.31	1.51
.70	2.32	1.85	1.27	1.07	1.00	1.00	1.00	1.02	1.10	1.36	1.59
.72	2.32	1.82	1.26	1.05	1.00	1.00	1.00	1.01	1.09	1.36	1.61
.74	2.30	1.74	1.21	1.03	1.00	1.00	1.00	1.01	1.07	1.34	1.58
.76	2.20	1.58	1.15	1.02	1.00	1.00	1.00	1.00	1.06	1.30	1.52
.78	2.11	1.47	1.09	1.01	1.00	1.00	1.00	1.00	1.05	1.25	1.46
.80	2.04	1.41	1.05	1.00	1.00	1.00	1.00	1.00	1.03	1.22	1.41
.82	1.98	1.36	1.03	1.00	1.00	1.00	1.00	1.00	1.02	1.19	1.37
.84	1.93	1.31	1.01	1.00	1.00	1.00	1.00	1.00	1.01	1.18	1.34

Table VI.

K

Cp	r	LCB 1% Forward.	LCB Amidships.	LCB 1% Aft.
.52	.823	.071	.075	.0785
.54	.841	.0695	.0725	.0750
.56	.860	.0690	.0705	.0720
.58	.870	.0680	.0690	.0700
.60	.880	.0685	.0680	.0680
.62	.890	.0685	.0680	.0680
.64	.890	.0695	.0680	.0685
.66	.890	.0705	.0700	.0715
.68	.890	.0730	.0725	.0745
.70	.890	.0750	.0745	.0770
.72	.890	.0770	.0765	.0790
.74	.895	.0785	.0775	.0800
.76	.903	.0795	.0785	.0800
.78	.914	.0805	.0795	.0800
.80	.925	.0815	.0805	.0800
.82	.937	.0820	.0805	.0795
.84	.948	.0825	.0810	.0790

* Concluded from the April issue.

of the center of gravity of a proposed ship can be closely gaged by proportioning to a similar vessel by depths of hull. To estimate vertical distance of metacenter above base, the "$B\ M$," or distance between center of buoyancy and metacenter and the height of the center of buoyancy above base, must be known. In obtaining "$B\ M$"

$$\text{which} = \frac{\text{Inertia of waterplane}}{\text{Volume of displacement}}$$

the inertia of waterplane can obviously be closely estimated for a design to be drawn by the use of the foregoing tables. As volume of displacement for a given value of C_p is proportional to the value of C_m adopted, we get the general expression:

$$B\ M = \frac{I}{c\ C_p\ C_m}$$, c being a constant dependent on dimensions.

Since $B\ M =$

$$\frac{a\ L\ B^3}{L \times B \times d \times C_b} = \frac{a\ L\ B^3}{L \times B \times d \times C_p \times C_m} = a \frac{B^2}{d\ C_p\ C_m}$$

where a is a coefficient, L, B and d being length, breadth and

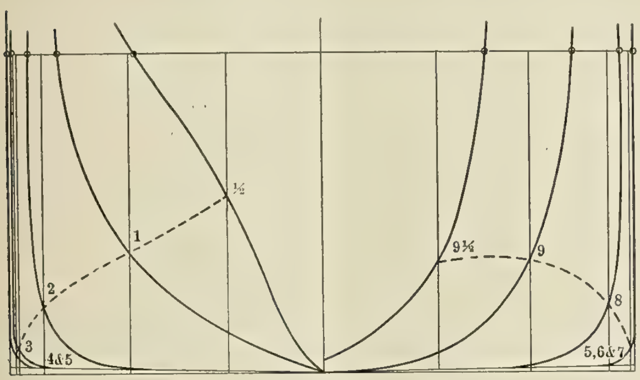


Fig. 4

draft, respectively, we get the formula $B\ M = K \frac{B^2}{d\ C_m}$ for any particular value of C_p.

The vertical position of center of buoyancy can be very closely figured by Morrish's formula, which may be expressed,

$$V.\ C.\ B. = \left(.833 - .333 \frac{C_p\ C_m}{C_w} \right) d.$$

C_w being coefficient of waterplane or area of waterplane ÷ length times breadth. Substituting r for $\frac{C_p}{C_w}$, the formula becomes $V.\ C.\ B. = (.833 - .333\ r\ C_m)$.

In Table VI the values K and r in these formulæ are given for varying values of C_p and position of center of buoyancy longitudinally, which latter affects waterplane inertia to some extent, but only very slightly alters $V.\ C.\ B.$

The use of the values K and r may be best illustrated by the following examples. A liner 650 feet by 73 feet by 49 feet to awning deck, 30-foot draft and 29,000 tons displacement, $L.\ C.\ B.$ being 0.5 percent of length aft, has to have $C\ M$ of 2.0 feet. The lines are designed by the foregoing methods, using a C_m of .960. From a similar vessel, whose $C.\ G.$ is known by inclining experiment, the height of center of gravity is estimated as 29.5 feet above keel. This entails a height of metacenter above base of 31.5 feet. Testing the proposed beam of 73 feet, we get $C_b = .713$; $C_p = \frac{.713}{.960} = .744$.

From Table VI, $r = .897$, $K = .079$.

Hence $V.\ C.\ B. = (.833 - .333\ r\ C_m)\ d.$
$= [.833 - (.333 \times .897 \times .960)]\ d.$
$= (.833 - .286)\ d = .547\ d = .547 \times 30.$
$= 16.4$ feet.

$$B\ M = .079 \frac{B^2}{d\ C_m} = .079 \times \frac{73^2}{30 \times .960} = 14.65 \text{ feet.}$$

M above base $= 16.4 + 14.65 = 31.05$ feet.

It is thus evident that either depth will have to be decreased, bringing down $C.\ G.$, or beam increased, which will give greater "M above base." Adding 2 feet to beam, which is the more practicable alternative, the calculation results (keeping displacement constant):

$C_b = .694$; $C_p = .723$.
$V.\ C.\ B. = 16.45$ feet above base.
$B\ M = 15.0$ feet.

31.45 M above base.

$G\ M = 31.45 - 29.5 = 1.95$ feet.

For design purposes this approximation is sufficiently accurate and rapid.

Electric Towing Locomotives for Panama Canal Locks

The first lot of electric towing locomotives for hauling vessels through the locks of the Panama Canal are now being received at the Isthmus. In all forty of these "electric mules" are being built by the General Electric Company, Schenectady, N. Y., for this purpose. The machines weigh 82,500 pounds; measure 32 feet 2½ inches long by 8 feet wide by 9 feet 3 inches, the greatest height over the cabs; have an available tractive effort as high as 47,500 pounds, and a windlass rope pull of 25,000 pounds. Four of these locomotives, two on each side, will ordinarily tow steamships through the locks. Sometimes six engines will be needed to handle extra large vessels; in every case two astern, acting as a brake on the ship's movements, will give direction to her course. No vessel will be allowed to enter the locks and go through under her own power.

The locomotive is built up of cast steel side and end frames, cross ties and bedplates. It is mounted on two axles with wheels in accordance with MOB standards. The entire frame is supported from journal boxes of the regular railway type by means of coiled springs. The sides and top of the body are enclosed by sheet iron covers which fit in place and are very easily removable. At each end are enclosed cabs so that the locomotive may be operated from either end.

The locomotive is propelled by means of a rack rail while towing, and while going up or down the steep grades from one level to another at a speed of 2 miles per hour. While running idle or on return tracks, the speed is changed to 5 miles per hour, and the machine is propelled by the regular traction method, the rack pinion being entirely released This change is effected by manually-operated clutches located in the gear mechanism in connection with a lever in each cab similar to a steam locomotive.

The locomotive is driven by two 75-horsepower totally-enclosed motors of the mill type, one being direct-connected through reduction gearing to each axle. Three-phase, 25-cycle, 220-volt current is used and is collected by contact plows.

The motor and traction gearing is mounted on a common baseplate, which in turn is mounted on a driving axle and spring suspended to the locomotive frame the same as in regular railway practice.

In the center of the locomotive is located a vertical windlass with drum, the capacity of which is 800 feet of 1-inch steel hawser cable. The windlass, with its driving motors and gearing, is mounted on a solid baseplate, and is likewise independent of the movement of the locomotive frame. The cable drum extends above the locomotive cover and has a floating guard placed around it to retain the cable while coiling loose.

The windlass cable is handled by two 20-horsepower motors, also totally enclosed and of the mill type. One is geared for a rope speed of 12 feet per minute at a pull up to 25,000 pounds at 2-foot radius, and its function is to adjust the position of the ship for anchor or while being towed through the locks. The other motor is geared for a rope speed of 200 feet per minute at 2-feet radius, and its duty is to take up slack or pay out cable or wind in any part of the entire length of cable as may be required. The cable drum is driven thorugh a friction device, which can be set at any desired value from zero up to the full capacity of the motor.

The traction motors as well as the windlass motors are controlled from either cab. In other words, the control equipment is duplicated. The two traction motors are operated by one master controller and contactors forward and reverse, while the windlass motors are operated by a reversible drum controller, and the clutch on the main vertical shaft by a solenoid.

Oil Tank Steamer Frank H. Buck

The First Longitudinally Framed Vessel Built on the Pacific Coast—Description of the Hull and Machinery

The *Frank H. Buck,* a steel single screw tank steamer, built for the Associated Oil Company by the Union Iron Works, San Francisco, Cal., is the first tank steamer built on the Pacific Coast on the Isherwood system. The keel of this vessel was laid on August 21, 1913. She was launched Feb. 11, 1914, and will be completed about April 15.

The ship has been constructed in accordance with Lloyd's requirements to Class 100 A 1 in Register. The principal dimensions and particulars of the vessel are as follows:

Length over all	426 feet 9 inches
Length between perpendiculars	410 feet 0 inch
Beam, molded	55 feet 3¾ inches
Depth, molded to upper deck	31 feet 8 inches
Load draft	27 feet 0 inch
Load displacement	13,960 tons
Cargo capacity	63,964 barrels
Fuel capacity	2,211 barrels
Gross tonnage	about 5,900
Engines	3-cylinder triple-expansion
Diameter of cylinders	26½, 45, 75 inches
Stroke	48 inches
Condenser cooling surface	3,755 square feet
Revolutions per minute	65
Designed indicated horsepower	2,600
Designed speed	10½ knots
Boilers	Four Scotch, single end
Length of boilers	11 feet 9 inches
Diameter boilers	14 feet 0 inch
Working pressure	200 pounds
Number of furnaces each boiler	3
Propeller	One four-bladed
Propeller, diameter	18 feet 9 inches
Propeller, pitch	18 feet 9 inches
Propeller, helical area	99.41 square feet

The hold is subdivided into tanks for carrying oil in bulk, the starboard and port compartments being separated by an oil-tight centerline bulkhead up to the top of the expansion trunk. The 'tween decks in the wings outside the expansion trunk is arranged for carrying ordinary freight. Fresh water is caried in a double bottom under the engines and boilers. A double bottom is also fitted forward for carrying either fresh water or ballast. The fore peak and after peak are also constructed for carrying fresh water.

The vessel is constructed with straight stem and elliptical stern, with two continuous decks and a raised forecastle. An open bridge is built amidships and a full poop aft. The vessel is rigged with three steel pole masts, with three cargo booms on the fore mast, two on the main mast, and one on the mizzen mast. Accommodations in the poop are fitted up for the engineers, stewards, firemen, seamen, etc. Upon the bridge deck amidships, enclosed in a steel house, accommodations are fitted up for the captain, deck officers and steward, consisting of a pantry, dining room, staterooms, bath room and toilets. Above this house and on a level with the flying bridge a teak wheel house and chart house are built. The vessel is provided with a No. 5 Shaw Spiegle towing machine installed aft, a Brown steam tiller, steam windlass and capstan, two powerful warping winches and two warping capstans.

Hull Construction

The vessel is constructed on the Isherwood system, with transverse framing abaft the engine room. The keel is of the flat plate type furnaced out at each end to properly meet the heels of the stem and stern frames. The stern is of wrought steel and the stern frame of cast steel in two sections, with well-proportioned scarphs. The rudder is of the single-plate type, the frame of forged steel with arms keyed to the stock, while the stock is in two pieces, with a coupling under the counter.

All erections on the poop and bridge, with the exception of the wheel and chart house, are of steel. All bulkheads in living quarters are stopped at the underside of the beams, the space above being fitted with expanded metal panels for ventilation.

Propelling Machinery

The propelling machinery consists of one three-cylinder triple-expansion engine, having cylinders 26½ inches, 45 inches and 75 inches diameter by 48-inch stroke, with independent condenser and bilge pumps. The engine drives a right-hand, four-bladed, built-up propeller with bronze blades and cast iron hub.

The main engines are fitted with Stephenson link motion for valve gear, the high-pressure and intermediate-pressure valves being of the piston type, and the low-pressure of the balanced slide type. The piston rods and valve stems are fitted with Tucker Improved United States double-block metallic packing.

The shafting is 10 percent heavier than Lloyd's requirements with male and female couplings and parallel coupling

Fig. 1.—Launch of the *Frank H. Buck* at the Union Iron Works, San Francisco, Cal., February 11

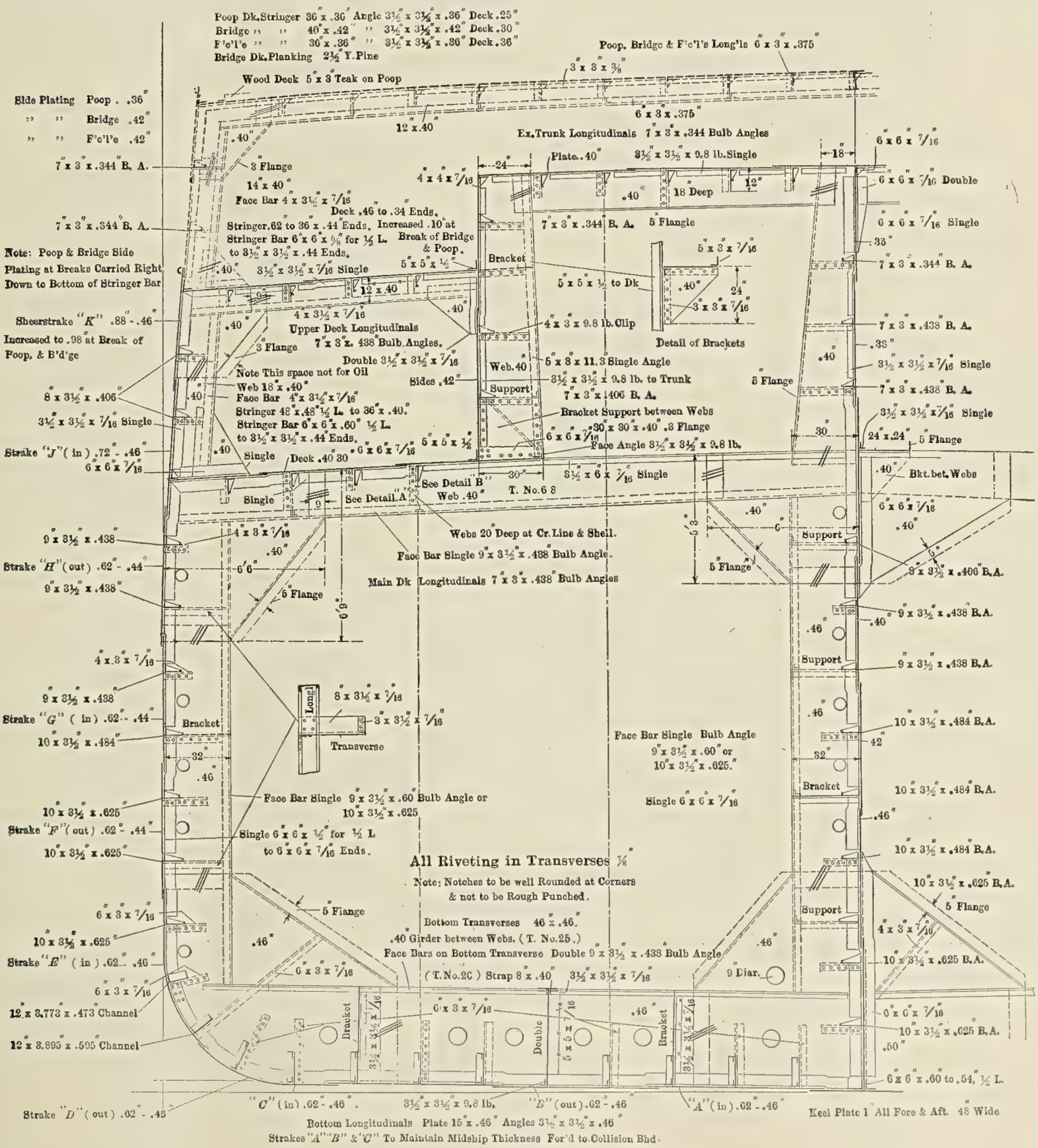


Fig. 2.—Midship Section of *Frank H. Buck*

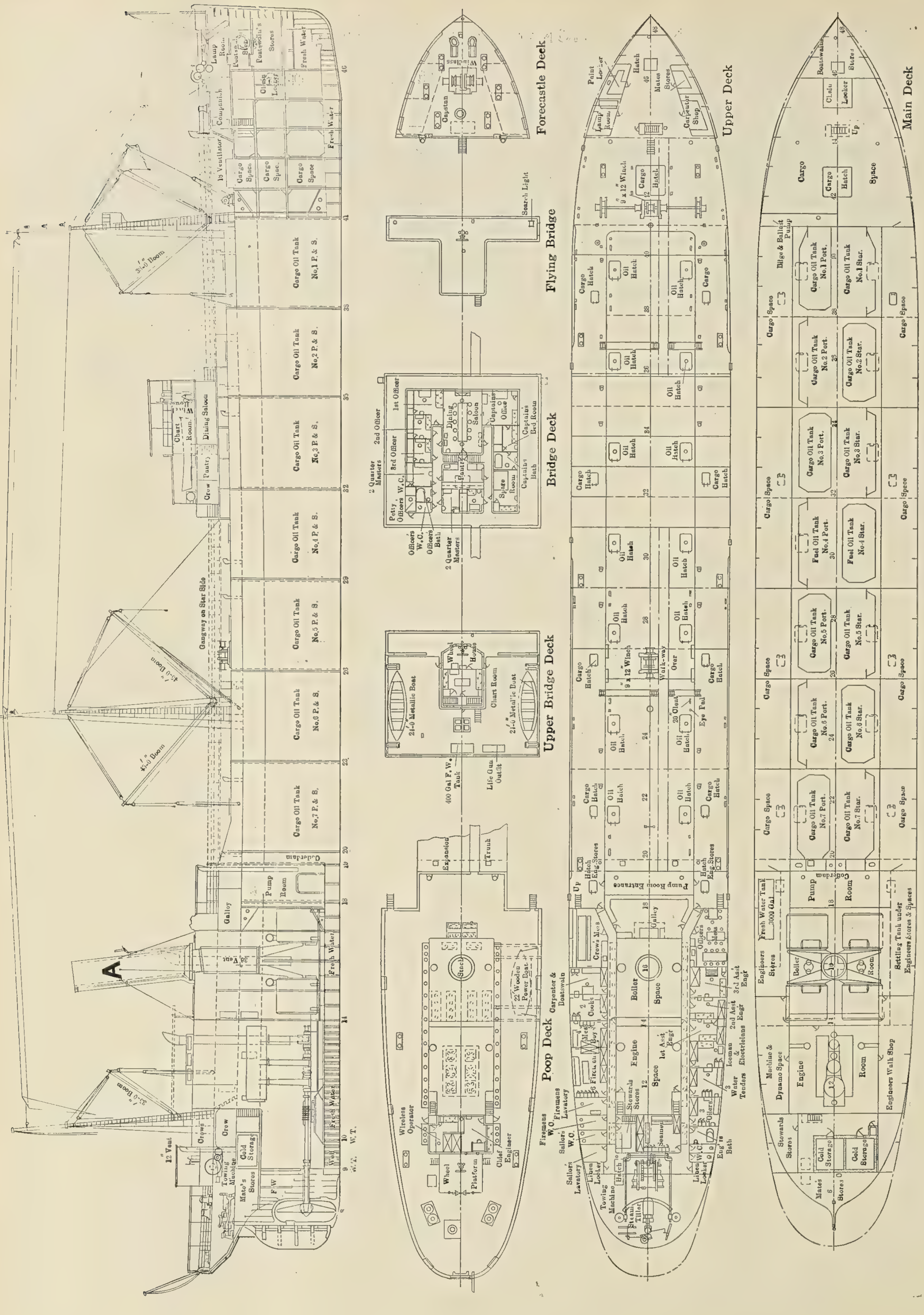


Fig. 3.—Profile and Deck Plans of Oil Tank Steamship *Frank H. Buck*

bolts. The thrust is of the horseshoe type, with the horseshoes cored for water circulation.

Steam is supplied to the engine by four single-ended Scotch marine boilers, each 14 feet diameter by 12 feet long, built for a steam pressure of 200 pounds per square inch. Each boiler is fitted with three Morison suspension furnaces about 42 inches diameter, with a separate combustion chamber to each furnace. The tubes are 3 inches external diameter, and a steam drum, 3 feet diameter by 6 feet long, is fitted to each boiler. The boilers have a total heating surface of 9,525 square feet and are fitted to burn fuel oil, the oil fuel system being of the Dahl type, which is almost universally used on the Pacific Coast and has given extremely satisfactory results.

An engineer's workshop is fitted up with one 22-inch drill press, one 20-inch by 14-foot lathe, one double emery grinder, bench vise and all necessary tools, the machinery being driven by a 7½ horsepower motor.

Auxiliaries

The auxiliary machinery consists of one main centrifugal circulating pump, driven by an independent direct-acting single-cylinder engine; an independent air pump; an auxiliary air pump; main and auxiliary feed pumps; a fire pump; sanitary pumps, and a feed water heater and evaporator plant.

The steering gear is of the Brown steam tiller type, with telemotor control. The electric plant consists of two 10-kilowatt generators, a switchboard, one 14-inch searchlight, and all accessories. The refrigerating plant is of Vulcan Iron Works' make, of two tons capacity, on the direct-expansion system, connected to the refrigerating chambers and to cooler tanks.

Lifeboat accommodations are provided for all on board the vessel by means of two 24-foot metallic lifeboats fitted complete with all necessary equipment as required by the United States laws. The boats are handled with Welin davits on the upper bridge. One 22-foot power boat is also provided. Life preservers and life buoys are carried as called for by law.

Cargo Handling

The cargo system consists of two duplex pumps having 18-inch cylinders, 15-inch oil cylinders and 18-inch stroke. The suction system consists of two 12-inch mains run one on each side of centerline bulkhead, with a 10-inch branch to each tank. Bypass arrangements are made so that any tank on one side of the ship can be emptied and discharged either overboard, through sea cocks or into any other tank on the opposite side.

Each pump can separately or together discharge into an 8-inch belt discharge main running along the top of the expansion trunk, from which 8-inch branches are fitted for discharging overboard, or back to the tanks by 6-inch branches. Discharges are so arranged that either pump can discharge into one side of the main or the other, and division valves are provided so that one pump can be working at a heavier pressure than the other. An independent 6-inch suction is fitted to one set of the main cargo tanks to discharge into the fuel tanks. The discharge system is so arranged that it can be used as suction for one or both pumps.

Each pair of tanks is fitted with a 6-inch equalizing valve. Two turbine fans are fitted in the pump room to discharge air either into the pump room or into 12-inch suction pipes to the cargo tanks.

Liquid Fuel.—At a meeting of the Institute of Marine Engineers on March 9, a paper was read by Mr. J. Veitch Wilson on "Liquid Fuel." In the course of an interesting historical retrospect, including a personal experience of over fifty years, he said it seemed reasonable to suppose, in view of the fact that so much petroleum had been found by spontaneous exudations and accidental discoveries, that the world was saturated with oil, and that, by systematic investigations, supplies were likely to be discovered in every habitable quarter of the globe. The world's production of crude petroleum showed a steady advance each year from 264,249,119 barrels in 1907 to 351,178,236 barrels in 1912, and he understood that the figures for 1913 showed an advance of 10 percent over those of 1912.

Comparative Costs of Warships Built in Government Navy Yards and in Private Shipyards

In the discussion of the Naval Appropriation Bill before Congress on April 21, Mr. William A. Jones, of Virginia, gave some interesting figures regarding the relative costs of naval vessels built in Government navy yards and by contract in private shipbuilding establishments. The figures for the most part were supplied either by the Secretary of the Navy or by the Chief of the Bureau of Construction and Repair, and include, besides the first cost of such vessels, a record of the cost of repairs on the ships since they have been in service. Taking the case of the battleship *Connecticut,* which was built eight years ago in the New York navy yard, it was shown that the *Conne ticut* cost $374,000 (£76,600) more than a sister ship, the *Louisiana,* built by contract at the yards of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., the cost of repairs on the *Connecticut* up to March 1, 1914, amounting to $31,000 (£6,360) more than the cost of repairs on the *Louisiana* up to the same date. Again, in the case of the Florida, which was also built at the New York navy yard, the first cost of the ship was $2,269,000 (£465,000) more than that of the *Utah,* a sister ship, built by contract at the New York Shipbuilding Company, Camden, N. J. The cost of repairs on the *Florida* up to March 1, 1914, amounted to $55,000 (£11,250) more than the cost of repairs on the *Utah.* Still another example for comparison was offered by the completion this year of the battleships *New York* and *Texas.* The *New York* was built in the New York navy yard, and cost $1,463,000 (£300,000) more than the *Texas,* a sister ship built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va. Notwithstanding that the total expenditures on the battleship *New York* up to March 1, 1914, indicate savings of $413,750.50 (£84,700) for the construction of the hull and $245,884.91 (£50,400) for the construction of the machinery as compared with the original estimates for the ship, and that additional amounts above the contract price of the *Texas* were paid by the Government for extra work on the *Texas,* nevertheless the Government-built ship *New York* cost the Government more than a million dollars more than the contract-built ship *Texas.* At present the Navy Department is requesting an appropriation for the construction of two battleships, eight destroyers and three submarines, the cost of which, exclusive of armor and armament, according to estimates of the Navy Department, would be, if built in private yards, about $25,600,000 (£5,250,000), while if the ships were built in navy yards the cost would be about $32,003,000 (£6,565,000), or about 28 percent more than the cost under private contract. The significance of these figures led Mr. Jones to oppose very strongly the policy of the Government in placing large contracts for the construction of naval vessels with navy yards, only two of which are at present properly equipped for building large ships, whereas there are now in the United States no less than five large private shipyards which have been developed in recent years very largely for the purpose of undertaking such work, and which have amply proved their ability to turn out the high grade of work demanded by the Navy Department under the most rigid inspection at a much less cost than is possible in navy yards.

Fig. 1.—Lundin Power Lifeboat Towing Open Lifeboats

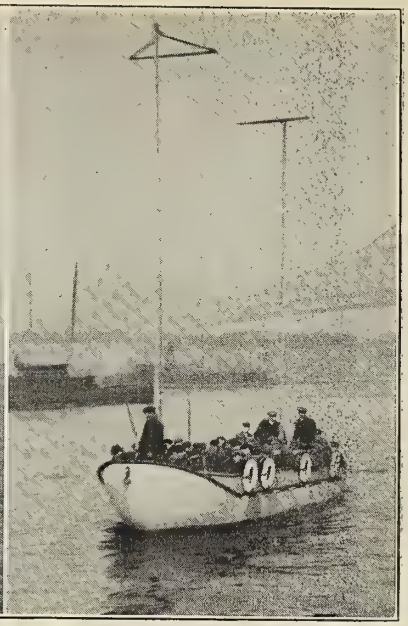


Fig. 2.—Open Power Lifeboat, with 64 Persons on Board

Tests of Lundin Lifeboats

The type of lifeboat developed by Capt. A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y., has been described in previous issues of this journal, and its principal features are probably well known to most of our readers. The Lundin lifeboat is essentially a broad, flat-bottom, round-ended scow-shaped boat built of high-grade steel plates galvanized as soon as they are rolled so that they are thoroughly protected from corrosion. The boats are completely decked over, with the space between the steel deck and the bottom of the boat subdivided by seven watertight bulkheads into watertight compartments, each compartment being fitted with a watertight manhole plate and self-acting scuppers, provided to carrying off any water that might get into the boat. The shape of the boat itself is conducive to strength, being that of a steel box girder of sufficient strength to stand the strain of being hoisted by steamships' davits with a full load on board.

Above the steel deck numerous heavy 'thwarts cross the boat, stiffening the hull still further and making her capable of withstanding the shocks to which she might be subjected in swinging against a ship's side while being lowered. As a further precaution, a thick Balsa wood fender, firmly fastened, but, at the same time, removable to permit of painting the inner surface, is fitted to each side of the boat. This fender not only rounds out the boat's shape nicely and protects it from damage, but also adds to its stability, as Balsa wood is much lighter than cork.

In the ordinary open Lundin lifeboats the sides and ends above the 'thwarts are made of wood capable of folding down to allow nesting of the boats one above the other, or, if it is unnecessary to nest the boats, the top sides can be made stationary.

One of the most recent types of lifeboats designed by Capt. Lundin is the power lifeboat illustrated in the accompanying photographs. A complete description of this type of boat was published in our June, 1912, issue, but since that date some new features have been incorporated in the design.

The power boat is practically a development of the standard Lundin decked lifeboat, but it is provided with a tunnel

Fig. 3.—Housed-in Power Lifeboat, with 50 Persons Inside and 17 Outside

Fig. 4.—28-Foot Lundin Lifeboat, with 61 Persons on Board, Lowered to the Water by Welin Quadrant Davits

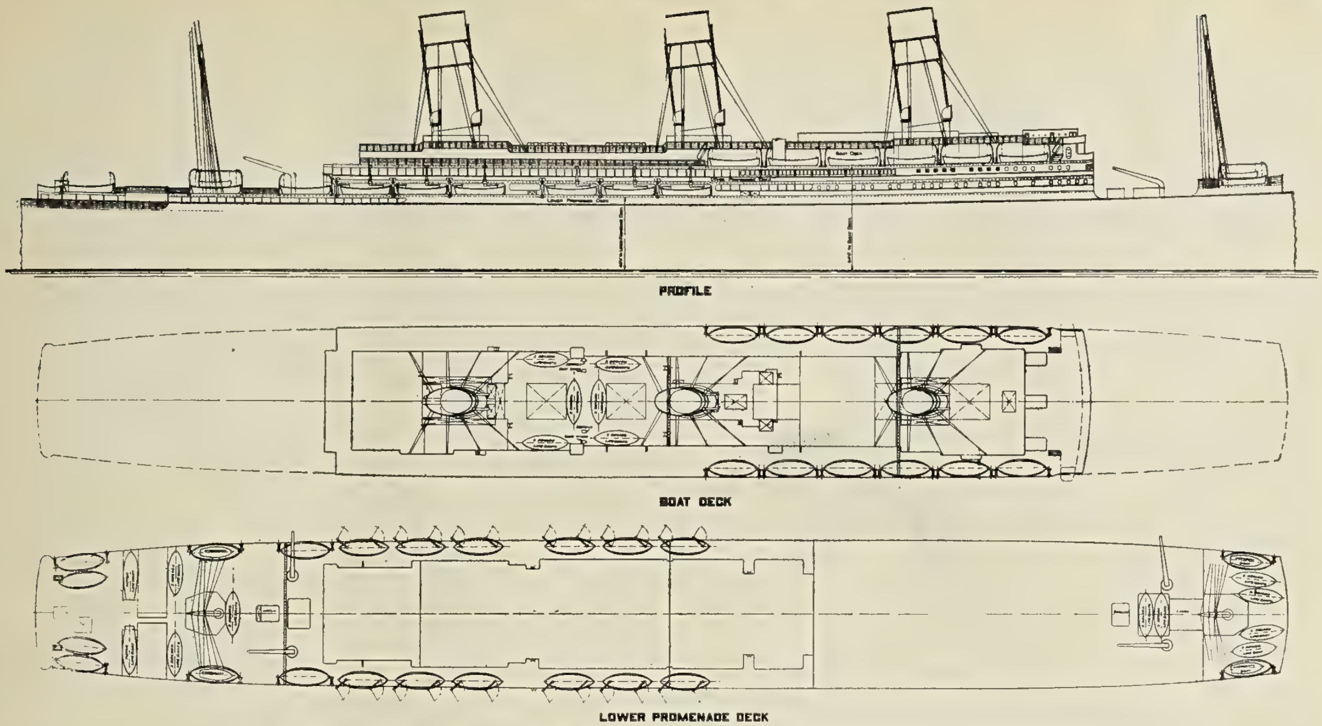


Fig. 5.—Present Arrangement of Lifeboats on the Hamburg-American Liner *Imperator*

stern in which the propeller is placed, so that it is entirely above the bottom of the boat, and well protected. The engine is placed in a watertight metal compartment, a little aft of amidships, so arranged that the lid forms a seat with the spark, throttle and clutch levers all arranged handy to the man at the helm, who thus after the motor has been started has full control of the boat.

The power lifeboat is fitted with tall hinged masts for carrying a wireless aerial, while the wireless apparatus is installed inside a Balsa wood silence cabin built in the forward part of the boat on the starboard side. The wireless equipment is a complete Marconi outfit similar to that used in the United States submarines for sending and receiving messages at distances from 50 to 100 miles at sea. Reels of strong rope and line-carrying guns for establishing communication with other boats, or to a ship, for the purpose of towing or rescue work, are also provided.

In view of the fact that many shipwrecked persons die of exposure in open boats, and that many women and children are included in the passenger lists of to-day, Capt. Lundin has had a strong but light sheet steel cabin put over these boats, and they are now being tested out. The steel cabin is built with large watertight doors at either end, and combination watertight port lights and rowlocks fitted along each side, enabling the boat to be maneuvered with oars while getting clear of the ship. This arrangement has proved a success

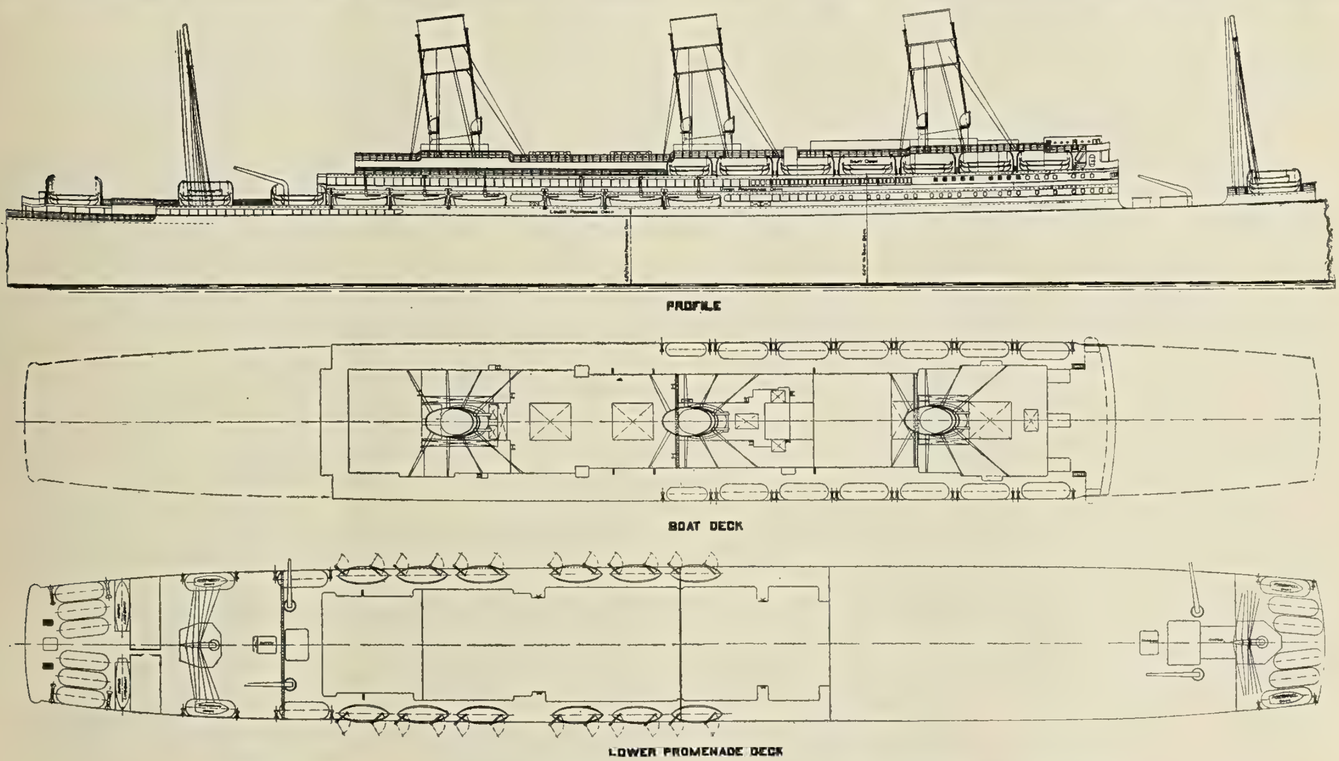


Fig. 6.—Proposed Arrangement of Lifeboats on the *Imperator* with Lundin Type of Boats

and involves no hindrance to the handling of the boat with oars. In extremely bad weather the windows and doors of the cabin can be clamped down absolutely watertight, as was proved under test when a 24-foot boat fitted with a similar cabin was parbuckled upside down, and as soon as the rope was slacked the boat righted herself immediately without shipping any water.

Recently a series of interesting tests of the Lundin lifeboats was made in the presence of General Uhler, Supervising Inspector-General of the United States Steamboat Inspection Service, and eight members of the Steamboat Inspection Service. In testing a 30-foot by 10-foot steel Lundin housed power lifeboat, fifty men were ordered by the inspectors to be seated inside the cabin, and when the boat was thus loaded

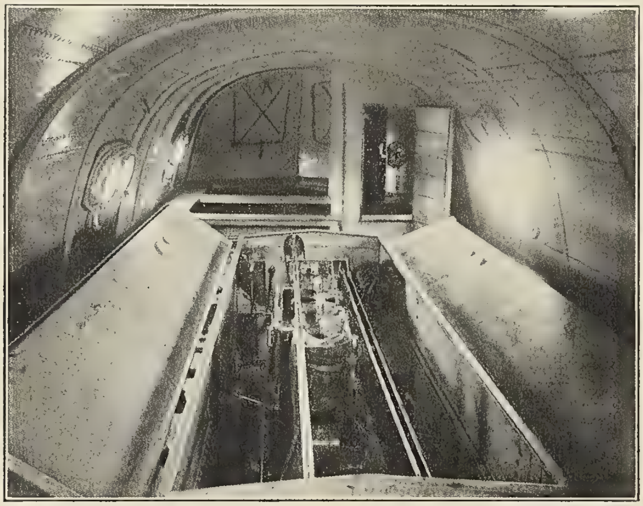


Fig. 7.—Interior of Cabin on Lundin Power Lifeboat, Showing Wireless Room and Motor

seventeen more men stood on the edge of the boat, outside the cabin, listing her only slightly, as shown in Fig. 3, her guard rail still being 2 inches above the water. It is difficult to say how many persons such a boat could save in case of disaster at sea, for, besides the fifty which could easily be accommodated inside the cabin, many more could in an emergency crowd onto her decks, hang onto the cabin top or to the lifeline stretched in loops along her sides.

In testing the seagoing qualities of the power lifeboat before the steamboat inspectors, the four-cylinder, 24 to 30-horsepower Standard motor, turning a 22-inch diameter three-bladed propeller, operating in the tunnel of the boat, gave the boat a speed of 6½ miles an hour, while taking a couple of other lifeboats in tow made no material difference in the speed. It is evident that such a boat could tow a string of other lifeboats and hold them head on to the sea, while by means of her wireless equipment calls could be sent to passing steamships.

The fact that the Lundin boats can be nested, so that two or more boats can be handled under a single set of davits, gives an opportunity for improving the conditions of stowing lifeboats on board ship. In the case of the largest passenger steamship now in service, the Hamburg-American Liner *Imperator,* the present arrangement of the lifeboats provides accommodations in lifeboats under davits on the boat, lower promenade decks, and on the forward and after deck houses for only 2,300 persons, while accommodations for 2,953 others are provided by lifeboats handled under booms. By using Lundin lifeboats, which can be nested two under each set of davits, accommodations for 5,160 persons can be provided by lifeboats under davits, as shown in the proposed arrangement indicated in Fig. 6. Only two lifeboats are handled under booms, these being motor boats with a total capacity for only 150 persons.

Chinese Junk Ning-Po

Few ships of any type now afloat can compare in age with the Chinese junk *Ning-Po,* a famous old smuggler and privateer craft now lying in Los Angeles harbor. Over a year ago this remarkable vessel was navigated from the Chinese coast to California under a Chinese crew and a Danish master, laden with a cargo of Chinese curios for exhibition at the Panama-Pacific Exposition next year.

Built so long ago as 1806, it was not without difficulty that the voyage of 7,000 miles across the North Pacific was accomplished. Off the coast of Japan she was swept by a vicious typhoon, and was partly dismantled by the storm. Part of her Chinese crew was lost through mutiny, and she suffered the humiliation of being rescued by a Japanese cruiser. After having weathered the gales of one hundred years, however, the barnacled bottom, weakened timbers and generally weather-worn appearance of the vessel are no rebuke to her remarkable Oriental builders.

The *Ning-Po* left the port of Shanghai September 17, 1912, and arrived in the harbor at San Pedro, Cal., February 10, 1913, being the first vessel to enter the port flying the flag of the new Chinese republic. For almost a year she laid at the various coast resorts adjacent to Los Angeles, and was finally moored in the harbor under the lee of the Government breakwater. One day last fall, as she swung unmanned at her moorings behind the protecting breakwater, a heavy storm overwhelmed her, and, with as little dignity as a mud scow, the vessel deliberately went to the bottom, only her masts remaining visible.

After this mishap, new owners acquired the *Ning-Po* and she was raised from the mud and taken to the Craig shipyard, Long Beach, Cal., for overhauling. Upon a recent visit to this yard, Mr. William T. Donnelly, consulting engineer, New York, had an opportunity of examining the vessel while she was in dry dock, and to him we are indebted for the following information.

The *Ning-Po* is 150 feet long, 35 feet beam, with a depth of but 15 feet. She has three decks, nine watertight bulkheads, and a maze of secret compartments that only a Chinese mind could conceive, making it apparent that she was built primarily for the smuggling trade. In dark corners in her hold are series of hiding places, many of her timbers being "gophered" out and the openings artfully concealed.

The vessel is of remarkable and unique construction, and to the Eastern shipbuilder most resembles the "buck-eye," familiar to the waters of Chesapeake Bay. The planking, which is of heavy timbers, is built up and bolted edgeways. Three heavy bilge strakes are from half-round logs scarfed to provide the curvature at the stern and bow. The vessel is calked both inside and out, and after being practically completed as to form and planking the frames are added from the inside.

The very strange and unique bow has quite a pleasing appearance, as it is decorated with the bulging eyes of a giant dolphin. This is a common feature of all Oriental vessels, as the superstitious Chinese sailor of the early days would as soon think of building a ship without a rudder as without an eye to see the dangers ahead.

The curious high stern resembles the historical vessels of the Columbus fleet. The planking of the stern is recessed, and this recess has a step to limit the set of the rudder, which, by the way, is no toy, as it is far heavier than would be expected on a vessel of this size. Across the upper part of the stern a counterboard, highly decorated, is worked in, and somewhere on this board is the name of *Ning-Po.* One of the illustrations shows an elaborate dragon worked on the starboard quarter.

Altogether the structure shows a surprising degree of skill and thoroughness in building, as evidenced by the durability of her camphorwood hull and her ironwood masts. Fig. 2 shows the rig to be fore-and-aft or a schooner rig with a

Fig. 1.—View on Deck of *Ning-Po*, looking aft

jigger mast on the high poop. This is the only apparent modification from true Oriental lines. A very novel feature observed was a hawser made from split and twisted bamboo. This was about 2½ inches in diameter and looked to be very strong. The rigging is of the familiar manila rope.

The *Ning-Po* was built at Foo-Chow in 1806, supposedly for the regular Formosan trade, although her intricate interior indicates that she was actually built for the popular and remunerative trade in which she was engaged through most of her sea-faring life, that of smuggling opium and slave girls. The original name of the *Ning-Po* was *Kin Tai Foong*, but in 1861 she was confiscated by the *Chinese Gordon* for rendering aid to the rebels at Ning-Po and her name was changed to the one which she has retained since.

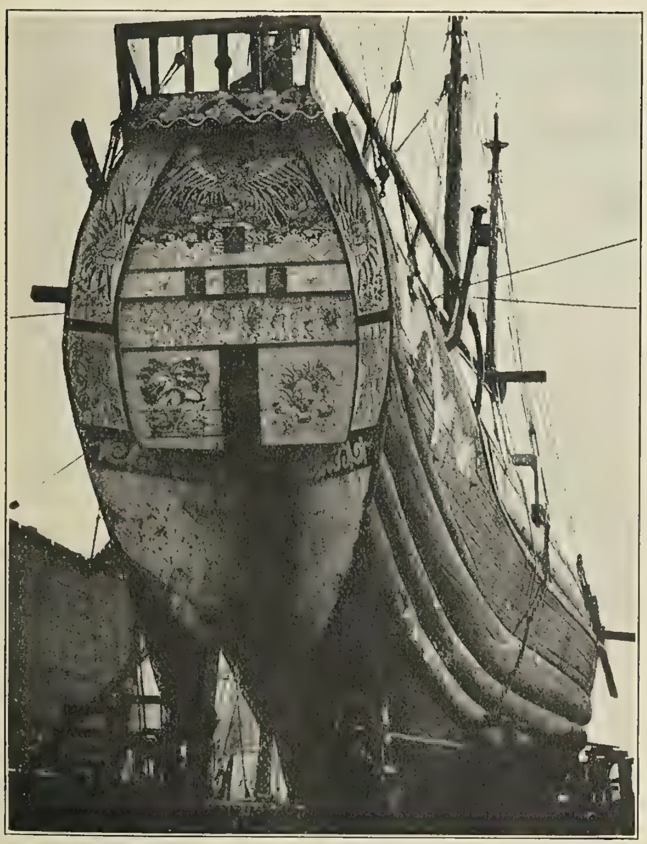


Fig. 2.—Stern of *Ning-Po*

Fig. 3.—The *Ning-Po* in Drydock, Showing Heavy Bilge Strakes

Convention for the Safety of Life at Sea

Abstract of the Text and Regulations of the International Convention for the Safety of Life at Sea Signed at London, January 20

The provisions of this convention are completed by regulations which have the same force and take effect at the same time as the convention. Every reference to the convention implies at the same time a reference to the regulations, copies of which should be secured for a complete understanding of the convention.

Except where otherwise provided by this convention, the merchant vessels of any of the contracting States which are mechanically propelled, which carry more than twelve passengers, and which proceed from a port of one of the said States to a port situated outside that State, or conversely, are subject to the provisions of this convention. Ports situated in the colonies, possessions or protectorates are considered to be ports outside the contracting States.

Persons who are on board by reason of force majeure or in consequence of the obligation laid upon the master to carry shipwrecked or other persons are not deemed to be passengers.

There are excepted from this convention, save in the cases where the convention otherwise provides, vessels making voyages specified in a schedule to be communicated by each high contracting party to the British Government at the time of ratifying the convention.

No schedule may include voyages in the course of which the vessels go more than 200 sea miles from the nearest coast.

Each high contracting party has the right subsequently to modify its schedule of voyages in conformity with this article on condition that it notifies the British Government of such modification.

Each high contracting party has the right to claim from another contracting party the benefit of the privileges of the convention for all of its vessels which are engaged in any one of the voyages mentioned in its own schedule. For this purpose the party claiming such benefit shall impose on the said vessels the obligations prescribed by the convention in so far as, having regard to the nature of the voyage, these obligations would not be unnecessary or unreasonable.

No vessel, not subject to the provisions of the convention at the time of its departure, can be subjected to the convention in the course of its voyage, if stress of weather or any other cause of force majeure compels it to take refuge in a port of one of the contracting States.

Safety of Navigation

When the expression "every vessel" is used forthwith, it includes all merchant vessels which belong to any of the contracting States.

The contracting parties undertake to take all steps to insure the destruction of derelicts in the northern part of the Atlantic Ocean east of a line drawn from Cape Sable to a point situated in latitude 34 degrees North and longitude 70 degrees West. Further, they will establish in the North Atlantic with the least possible delay a service for the study and observation of ice conditions and a service of ice patrol. For this purpose:

Two vessels shall be charged with these three services.

During the whole of the ice season, they shall be employed in ice patrol.

During the rest of the year the two vessels shall be employed in the study and observation of ice conditions and in the destruction of derelicts; nevertheless the study and observation of ice conditions shall be effectively maintained, in particular from the beginning of February to the opening of the ice season.

While the two vessels are employed in ice patrol the contracting parties, to the extent of their ability and so far as the exigencies of the naval service will permit, will send warships or other vessels to destroy any dangerous derelicts, if this destruction is considered necessary at that time.

The government of the United States is invited to undertake the management of the three services of derelict destruction, study and observation of ice conditions, and ice patrol. The contracting States which are specially interested in these services undertake to contribute to the expense of establishing and working the said services in the following proportions: United States of America, 15 percent; France, 15 percent; Germany, 15 percent; Great Britain, 30 percent, and the others in amounts varying from 2 to 4 percent.

The master of every vessel which meets with dangerous ice or a dangerous derelict is bound to communicate the information by all the means of communication at his disposal to the vessels in the vicinity, and also to the competent authorities at the first point of the coast with which he can communicate. Every administration which receives intelligence of dangerous ice or a dangerous derelict shall take all steps which it thinks necessary for bringing the informatiton to the knowledge of those concerned and for communicating it to other administrations. The transmission of messages respecting ice and derelicts is free of cost to the vessels concerned. It is desirable that the said information should be sent in a uniform manner. For this purpose, a code, the use of which is optional, has been prepared.

The master of every vessel fitted with a radiotelegraph installation, on becoming aware of the existence of an imminent and serious danger to navigation, shall report it immediately. When ice is reported on, or near, his course, the master of every vessel is bound to proceed at night at a moderate speed, or to alter his course so as to go well clear of the danger zone.

The use of the international distress signals for any other purpose than that of signals of distress is prohibited on every vessel. The use of private signals which are liable to be mistaken for the international distress signals is prohibited on every vessel.

The selection of the routes across the North Atlantic in both directions is left to the responsibility of the steamship companies. Nevertheless, the contracting parties undertake to impose on these companies the obligation to give public notice of the regular routes which they propose their vessels should follow, and of any changes which they make in them. They undertake, further, to use their influence to induce the owners of all vessels crossing the Atlantic to follow as far as possible the routes adopted by the principal companies.

The contracting parties undertake to use all diligence to obtain from the governments which are not parties to this convention their agreement to the revision of the International Regulations for Preventing Collisions at Sea, as indicated below:

Article 2. The second white mast-head light to be compulsory. Article 10. A permanent fixed stern light to be compulsory. Article 14. A special day signal to be compulsory for motor vessels. Article 15. A special sound signal to be established for use by a vessel in tow, or if the tow is composed of several vessels, by the last vessel of the tow. Ar-

ticle 31. Add to the lists of both day and night signals the international radiotelegraph distress signal.

The governments of the contracting parties undertake to maintain, or, if it is necessary, to adopt, measures for the purpose of insuring that, from the point of view of safety of life at sea, the vessels to which this convention applies shall be sufficiently and efficiently manned.

Construction

"New vessels" are those the keel of which is laid after July 1, 1915. Other vessels are considered as "existing vessels." Existing arrangements on each of these vessels shall be considered by the administration of the State to which the vessel belongs, with a view to improvements providing increased safety where practicable and reasonable.

Subdivision of Vessels

Vessels shall be as efficiently subdivided as is possible, having regard to the nature of the service for which they are intended. The minimum requirements respecting subdivision and arrangements affecting subdivision are given. The degree of safety provided for by these minimum requirements varies in a regular and continuous manner with the length of the vessel and with a certain "criterion of service." The requirements of the annexed regulations are such that the highest degree of safety corresponds with the vessels of greatest length primarily engaged in the transportation of passengers. The regulations indicate the method to be followed in order to determine the permissible length of compartments on the basis of the floodable length; prescribe a limit to the length of compartments; and fix the conditions governing certain special cases.

When the watertight subdivision of a vessel is such as to provide for a degree of safety greater than that provided by the rules prescribed by this convention, the administration of the State to which the vessel belongs shall, if so requested by the owner, record this fact on the safety certificate of the vessel.

Floodable Length

The floodable length at any point of the length of a vessel shall be determined taking into consideration form, draft, and other limiting characteristics of the vessel in question.

This floodable length for a given point in a vessel with a continuous bulkhead deck is the maximum percentage of the length of the vessel (having its center at the point in question) which can be flooded under the definite assumptions hereafter set forth without the vessel being submerged beyond the margin line.

In the case of vessels not having a continuous bulkhead deck, the floodable length must be such as to secure to the vessel in question, for each portion of its length, and for all conditions of trim after damage, a measure of safety at least equal in effectiveness to that laid down for the vessel with continuous bulkhead deck.

In determining the floodable length a uniform average permeability shall be used throughout the whole length of each of the three following portions of the vessel:

(1) The machinery space;

(2) The portion forward of the machinery space; and

(3) The portion abaft the machinery space.

For steam vessels the permeability of the machinery space, including the double bottom in wake thereof, shall be taken as 80 percent. For vessels fitted with internal combustion engines the corresponding permeability shall be taken as 85 percent, unless it is proved by actual calculation that a lower figure may be adopted, provided that in no case shall that figure be less than 80 percent.

The permeabilities for spaces forward and aft of the machinery space shall be as follows:

(*a*) Sixty percent in cargo spaces, bunkers (permanent or reserve), storerooms, baggage and mail rooms, chain lockers, watertight shaft or pipe tunnels, and fresh-water tanks above the double bottom.

It must be proved that the spaces just enumerated are practicable for the purpose intended and that they are in fact to be so used. The same permeability shall not be assigned to any other space without the approval of the administration.

(b) Ninety-five percent in passenger and crew spaces, peaks, trimming tanks exclusively so used, double bottoms, and all other spaces not specifically appropriated to one of the purposes indicated in the foregoing section (*a*).

If in a 'tween deck space inclosed by complete transverse permanent steel bulkheads any portion thereof is appropriated to passengers, the whole of that space shall be regarded as passenger space; and, similarly, 'tween deck spaces appropriated for the carriage of *either* passengers *or* cargo shall be regarded as passenger spaces.

Where the spaces before or abaft the machinery space below the margin line consist partly of spaces mentioned in section (*a*) and partly of spaces mentioned in section (*b*), the average percentage of permeability shall be determined separately for each end by the formula $95—35\,r$, where r is the ratio between the volume of the spaces mentioned in section (*a*) and the total volume of the space in the portion of the ship under consideration.

Permissible Length of Compartments

(1) The maximum permissible length of one compartment having its center at any point in the vessel's length is obtained from the floodable length by multiplying that length by an appropriate factor, called the *factor of subdivision*.

(2) This factor of subdivision depends on the length of the vessel, and, for a given length, varies according to the nature of the service for which the vessel is intended. This factor decreases in a regular and continuous manner—

(*a*) As the length of vessel increases; and

(*b*) As, for a given length, the vessel departs from the type of vessel engaged in a mixed cargo and passenger service, and approaches to the type of vessel primarily engaged in the transportation of passengers.

(3) For each of the two types of vessels referred to in the previous paragraph (2) (*b*) the variation of the factor of subdivision may be expressed by a curve, of which the coordinates represent the length of the vessel and the value of the factor. The following table gives certain points on two curves the higher of which corresponds to the minimum requirements for the "mixed" type, and the lower to the minimum requirements for the "passenger" type.

Table

	B.		C.	
A.	Meters.	Feet.	Meters.	Feet.
1.00	90	295	79	259
0.90	114	374	87	285
0.84	123	404	93	305
0.65	149	489	116	380
0.50	174	571	149	489
0.39	213	699	209	685
0.34	274	899	274	899

Column A gives the maximum permissible values of the factor of subdivision for the length of vessels given in Columns B and C.

Column B is applicable to vessels engaged in the mixed cargo and passenger service.

Column C is applicable to vessels primarily engaged in the transportation of passengers.

(4) For a given length, the value of the factor of subdi-

vision appropiate to a vessel between the two extreme limits will be between the values of the factors determined by the two curves before mentioned, and will be automatically fixed by a *"criterion of service"* which is to form the subject of further study.

(1) When the factor of subdivision is equal to or less than .5, it may be doubled in order to give at any point of the vessel's length the total length of two adjacent compartments; but in that case the length of the shorter compartment of any pair shall not be less than one-quarter of the total length so obtained. If one of the two adjacent compartments is situated inside the machinery space and the second is situated outside the machinery space, and the average permeability of the portion of the ship in which the second is situated differs from 80 percent, the length of the pair of compartments shall be adjusted to the proper value by applying a suitable correction.

(2) In no case whatever shall the length of any watertight compartment exceed 28 meters (equivalent to 92 feet).

(3) When the factor of subdivision applicable to any vessel is less than .84, but more than .5, the combined length of the two foremost compartments shall not exceed the floodable length at the extreme forward end, provided also that the length of the second compartment is not greater than that permissible by the above, and not less than 3 meters (equivalent to 10 feet).

(4) When the length of the vessel is more than 213 meters (equivalent to 699 feet) but less than 251 meters (equivalent to 823 feet) the floodable length at the forward end of the vessel shall be at least 20 percent of the vessel's length; and the vessel, forward of a bulkhead placed either at the distance of the actual floodable length abaft the stem or not nearer to the stem than 20 percent of the vessel's length, shall be divided into at least three compartments.

(5) When the length of the vessel is equal to or greater than 251 meters (equivalent to 823 feet) the same method shall be adopted, but the floodable length shall be at least 28 percent and the number of compartments at least four.

(6) A bulkhead may be recessed transversely, provided the sides of the recess are of a sufficient distance from the sides of the vessel.

Vertical steps are inadmissible in the main transverse watertight bulkheads of vessels to which the subdivision rules apply where the factor of subdivision is greater than .5, unless such arrangements are made by additional subdivision as shall maintain the same measure of safety as that secured by bulkheads without steps. The total length of the steps in any bulkhead shall not exceed 2 percent of the vessel's length, plus 3 meters (equivalent to 10 feet).

(7) The existence of recesses or steps in a bulkhead shall in no case affect the permissible volumes of the compartments adjacent to such bulkhead, as determined by this and the preceding article.

Peak and Machinery Space Bulkheads

Vessels shall be fitted with a forepeak bulkhead to extend to the bulkhead deck, and to the weather deck in vessels having continuous superstructures. This bulkhead shall be placed at a distance of not less than 5 percent of the vessel's length from the stem at the load waterline.

An afterpeak bulkhead and bulkheads dividing the machinery space from the cargo and the passenger spaces shall also be fitted and carried up to the bulkhead deck. The afterpeak bulkhead may, however, be stopped below the bulkhead deck, provided that it shall at least be carried to the first deck above the load waterline, and that such deck forms a watertight flat from the afterpeak bulkhead to the stern, and also provided that the degree of safety of the vessel as regards subdivision is not thereby diminished.

Fireproof Bulkheads

In parts of a vessel above the margin line there shall be fitted fireproof bulkheads which will serve to retard the spread of fire. The mean distance between any two consecutive bulkheads of this description shall not be greater than 40 meters (equivalent to 131 feet). Recesses in these bulkheads shall be fireproof, and the openings in these bulkheads shall be fitted with fireproof doors.

Exits from Watertight Compartments

(1) In passenger and crew spaces a practicable means of escape for the occupants shall be provided from each watertight compartment.

(2) There shall be a means of escape for the crew from each engine room, shaft tunnel and stokehold compartment independent of the watertight doors.

Construction and Initial Testing of Watertight Bulkheads

(1) Watertight bulkheads shall be constructed in such a manner that they shall be capable of supporting, with a proper margin of resistance, the pressure due to a head of water up to the margin line.

(2) Steps and recesses in bulkheads shall be as watertight and as strong as the bulkhead at the place where each occurs.

Where frames or beams pass through a watertight deck or bulkhead, the watertightness shall be obtained by calked angle chocks, or cast iron or steel chocks efficiently secured and rust-jointed, and not by wood or cement.

(3) Testing main compartments by filling them with water is not compulsory. A complete examination of the bulkheads shall be made by a surveyor; and, in addition, a hose test shall be made in all cases.

(4) The foremost and aftermost compartments shall be tested with water to a head up to the margin line.

Double bottoms, double tanks, and all compartments intended to hold liquids shall be tested with water to a head of 2.44 meters (8 feet) above the top of the tank or to the load waterline, whichever is the greater.

(5) No change may be made in the structure of the bulkheads after the completion of the survey without the permission of the administration.

(6) All provisions relating to main transverse watertight bulkheads shall apply to longitudinal bulkheads, so far as is practicable.

Openings in Watertight Bulkheads

(1) The number of openings in watertight bulkheads shall be reduced to the minimum compatible with the design and proper working of the vessel; satisfactory means shall be provided for closing these openings.

(2) No doors, sluice valves, manholes, or access openings are permitted—

(*a*) In the collision bulkhead below the margin line.

(*b*) In watertight transverse bulkheads dividing a cargo space from an adjoining cargo space or from a reserve bunker, except as provided in paragraph 6 of this article.

(3) In the machinery space and apart from bunker and shaft-tunnel doors, not more than one door may be fitted in each main transverse bulkhead within the machinery space for intercommunication, but where more than one separate shaft tunnel is fitted a door may be cut for each tunnel.

If a tunnel is fitted forward either for the purpose of pipes or as a communication passage it shall be fitted with a watertight door.

(4) The only types of watertight doors permissible are hinged doors, sliding doors, and doors of any other equivalent pattern, excluding plate doors secured only by bolts.

A hinged door shall be fitted with lever-operated catches workable from each side of the bulkhead.

A sliding door may have a horizontal or vertical motion. If hand-operated only, the door shall be capable of being operated at the door itself and also from an accessible position above the margin line. If operated by power, it shall be capable of being operated from the bridge, and by hand at the door itself and from an accessible position above the margin line. A door dropping by its own weight, and fitted with a cataract cylinder or equivalent arrangement, may be considered as being operated by power, if capable of being released from the bridge.

(5) In the case of watertight bunker doors, satisfactory arrangements shall be made by means of screens or otherwise, to prevent the coal from interfering with the closing of the doors.

(6) Hinged watertight doors in passenger, crew, and working spaces are only permitted above a deck the under side of which, at its lowest point at side, is at least 2.13 meters (7 feet) above the load waterline, and they are not permitted in those spaces below such deck.

Hinged watertight doors of specially heavy design may be fitted above the load waterline in bulkheads between cargo 'tween-deck spaces. They shall be closed before the voyage commences, and kept closed while at sea by efficient closing gear. None of these doors shall be fitted, even at the ends of the vessel, in a cargo 'tween-deck space in the amidship region of which 'tween-deck space it would not be permissible to fit such doors.

(7) All other watertight doors shall be sliding doors.

(8) (*a*) When the number of watertight doors in the main transverse watertight bulkheads at or about the stokehold level in the machinery space exceeds five, excluding the watertight doors at the entrances of tunnels, all watertight doors situated below the load waterline shall be capable of being simultaneously closed from a station situated on the bridge, and their opening and closing shall be indicated at that station. The simultaneous closing of these doors shall be preceded by a warning sound signal.

(*b*) If watertight doors which have sometimes to be open at sea for the purpose of trimming coal are fitted between bunkers in the 'tween-decks opening below the bulkhead deck, these shall be operated by power. The opening and closing of these doors shall be recorded in the official log.

(*c*) When trunkways in connection with refrigerated cargo are carried through more than one main transverse watertight bulkhead, and the sills of the openings are less than 2.13 meters (7 feet) above the load waterline, the watertight doors at such openings shall be operated by power.

(9) Portable plates on bulkheads shall not be permitted except in machinery spaces. Such plates shall always be in place before the vessel leaves port, and shall not be removed at sea except in case of urgent necessity. The necessary precautions shall be taken in replacing them to insure that the joint shall be perfectly watertight.

(10) All watertight doors shall be kept closed during navigation except when necessarily opened for the working of the vessel, and shall always be ready to be immediately closed.

(11) If trunkways for forced draft, for access from crew's accommodation to the stokehold or for any other purpose, are carried through the main transverse watertight bulkheads, the integrity of the watertight bulkheads shall be maintained by watertight doors or other equally effective means.

(12) Where pipes, electric light cables, etc., are carried through transverse watertight bulkheads below the margin line, arrangements shall be made to insure the integrity of the watertightness of the bulkheads.

(13) The number of sluice valves in watertight bulkheads shall be reduced to the minimum, and shall not be allowed except in positions where they are sufficiently accessible at all times to allow of its being ascertained that they are in good order. They shall be strongly constructed, efficiently fitted, and regularly inspected. Satisfactory provision shall be made for operating them from an accessible position above the margin line. Means shall be provided for indicating when they are open or shut.

Openings in Vessel's Side

(1) (*a*) Subject to clause (*b*) below, when side scuttles are fitted below a deck the under side of which at its lowest point at side is less than 2.13 meters (7 feet) above the load waterline, they shall be permanently fixed.

(*b*) Side scuttles which are capable of being opened may be fitted in the positions defined in clause (*a*), provided that—

They shall be closed watertight and locked before the vessel leaves port; they shall not be opened during navigation; the time of opening such scuttles in port and of closing and locking them before the vessel leaves port shall be entered in the official log; the construction of such scuttles shall be such as effectively to prevent any person opening them without the consent of the master.

(*c*) Scuttles fitted in the positions defined in clause (*a*) shall be provided with efficient metal shutters.

(2) In 'tween decks above the deck mentioned in paragraph (1) (*a*) of this article, opening side scuttles may be fitted except in spaces exclusively devoted to the carriage of cargo or coal.

(3) No side scuttles shall be fitted in any spaces which are exclusively devoted to the carriage of cargo or coal.

(4) All side scuttles which are not accessible during navigation shall be fitted with efficient metal covers, and both the glass and the cover shall be kept closed during navigation.

(5) No automatic ventilating scuttles shall be fitted in the ship's side below the margin line.

(6) All inlets and discharges in the side shall be arranged so as to prevent any accidental admission of water into the vessel.

(7) The number of scuppers, sanitary discharges, and other similar openings in the side shall be reduced to the minimum, either by making each discharge serve for as many as possible of the sanitary and other pipes or in any other satisfactory manner.

(8) Discharges led through the vessel's skin from spaces below the margin line shall be fitted with efficient and accessible means for preventing water from passing inwards. It is permissible to have either one valve, fitted with a means of working it at a distance, or two valves without such gear, one of these valves being always accessible. In either case, the accessibility of the valves or of the means of working shall be assured by their being situated above the deck referred to in paragraph (1) (*a*) of this article.

(9) In no case shall gangway, cargo, and coaling ports be fitted below the load waterline. None of these ports shall be fitted, even toward the ends of the vessel, in a space below the lowest 'tween-deck space in the amidship region of which it is permissible to fit such ports.

(10) Gangway, cargo, and coaling ports in the vessel's side below the margin line shall be effectively closed and made secure before the vessel leaves port, and kept closed during navigation.

(11) The inboard openings of ash shoots, rubbish shoots, etc., shall not be lower than the deck referred to in paragraph (1) (*a*) of this article. They may be permitted above this deck if fitted, to the satisfaction of the administration, with covers, which shall be watertight if below the margin line. Such covers shall be so arranged as to prevent their being clogged in any way, and shall be at least as easily and effectively closed as watertight doors and side scuttles.

Construction and Tests of Watertight Doors, Side Scuttles, etc.

(1) The design and the materials used in the construction of watertight doors, side scuttles, gangway, coaling and cargo

ports, valves, pipes, ash and rubbish shoots shall be to the satisfaction of the administration.

(2) Watertight doors shall be tested by a water pressure equal to that prescribed for the bulkhead where the doors are located. The test shall be made before the vessel is put in service, and either before or after the door is fitted.

Construction and Initial Tests of Watertight Decks, Trunks, etc.

(1) Watertight decks, trunks, and ventilators shall be of the same strength as the watertight bulkhead at the place where they occur. The means used for making them watertight and the arrangements adopted for closing the openings in them shall be to the satisfaction of the administration. If watertight covers are used for closing these openings, they shall be fitted before the vessel leaves port, and kept closed during navigation.

(2) After completion a hose or reflooding test shall be applied to watertight decks and a hose test to watertight trunks. Watertight ventilators and trunks shall be carried at least up to the margin line.

(3) No change shall be made in the structure of watertight decks, trunks and ventilators after the survey without the permission of the administration.

Periodical Operation and Inspection of Watertight Doors, etc.

In all vessels to which this convention applies, drills for the operating of watertight doors, side scuttles, valves, and closing mechanisms of scuppers, ash shoots and rubbish shoots, shall take place periodically during the voyage. A complete drill shall take place before leaving port, a second as soon as practicable after leaving port, and others thereafter at least once a week during the voyage, provided that all watertight power doors and hinged doors in main transverse bulkheads in use at sea shall be operated daily.

The watertight doors and all mechanisms and indicators connected therewith, and all valves the closing of which is necessary to make a compartment watertight, shall be periodically inspected at sea, at least once a week.

Hinged doors, portable plates, side scuttles, gangway, cargo and coaling ports, and other openings, which are required by the preceding rules to be kept closed during navigation, shall be closed before the vessel leaves port. The time of closing, and the time of opening (if permissible under these regulations), shall be recorded in the official log book.

A record of all drills and inspections required shall be entered in the official log book with an explicit record of any defects.

Double Bottoms

(1) In vessels 61 meters (equivalent to 200 feet) and under 76 meters (equivalent to 249 feet) in length, a double bottom shall be fitted at least from the machinery space to the forepeak bulkhead, or as near thereto as practicable.

(2) In vessels 76 meters (equivalent to 249 feet) and under 91.5 meters (equivalent to 300 feet) in length, a double bottom shall be fitted at least outside of the machinery space and shall extend to the fore and after peak bulkheads respectively, or as near thereto as practicable.

(3) In vessels 91.5 meters (equivalent to 300 feet) and over in length, a double bottom shall be fitted amidships and shall extend to the fore and after peak bulkheads respectively, or as near thereto as practicable.

(4) In vessels of over 91.5 meters (equivalent to 300 feet) in length, the inner bottom shall be continued out to the vessel's side in such manner as to protect the bilges.

(5) In vessels over 213 meters (equivalent to 699 feet) in length, the double bottom, for at least half the vessel's length amidships and forward to the forepeak bulkhead, shall extend up the vessel's sides to a height above the top of the keel not less than 10 percent of the vessel's molded breadth.

(6) Wells constructed in the double bottom in connection with the drainage arrangements shall not extend downwards from the inner bottom more than half the depth of the double bottom at that point. A well extending to the outer skin is, however, permitted at the after end of the shaft tunnels of screw vessels.

Every vessel defined shall be subjected at least to the following surveys: (*A*) A survey before the vessel is put in service; (*B*) Periodical surveys once each year; and (C) Additional surveys, as occasion arises.

Radiotelegraphy

All merchant vessels belonging to any of the contracting States, whether they are propelled by machinery or by sails, and whether they carry passengers or not, shall, when engaged on the voyages specified, be fitted with a radiotelegraph installation, if they have on board 50 or more persons in all.

Vessels on which the number of persons on board is exceptionally and temporarily increased up to or beyond 50 as the result of force majeure, or because the master is under the necessity of increasing the number of his crew to fill the places of those who are ill, or is obliged to carry shipwrecked or other persons, are exempted from the above obligation.

Moreover, the governments of each of the contracting States, if they consider that the route and the conditions of the voyage are such as to render a radiotelegraph installation unreasonable or unnecessary, may exempt from the above requirement the following vessels:

(1) Vessels which in the course of their voyage do not go more than 150 sea miles from the nearest coast.

(2) Vessels on which the number of persons on board is exceptionally or temporarily increased up to and beyond 50 by the carriage of cargo hands for a part of the voyage, provided that the said vessels are not going from one continent to another, and that, during that part of their voyage, they remain within the limits of latitude 30 degrees North and 30 degrees South.

(3) Sailing vessels of primitive build, such as dhows, junks, etc., if it is practically impossible to install a radiotelegraph apparatus.

Vessels which are required to be fitted with a radiotelegraph installation are divided, for the purpose of radiotelegraph service, into three classes:

First Class—Vessels having a continuous service.

There shall be placed in the first class vessels which are intended to carry 25 or more passengers—

(1) If they have an average speed in service of 15 knots or more;

(2) If they have an average speed in service of more than 13 knots, but only subject to the twofold condition that they have on board 200 persons or more (passengers and crew), and that, in the course of their voyage, they go a distance of more than 500 sea miles between any two consecutive ports. Nevertheless, these vessels may be placed in the second class on condition that they have a continuous watch.

Second Class—Vessels having a service of limited duration.

There shall be placed in the second class all vessels which are intended to carry 25 or more passengers, if they are not, for other reasons, placed in the first class.

Vessels placed in the second class must, during navigation, maintain a continuous watch for at least 7 hours a day, and a watch of 10 minutes at the beginning of every hour.

Third Class—Vessels which have no fixed periods of service.

All vessels which are placed neither in the first nor in the second class shall be placed in the third class.

The owner of a vessel placed in the second or in the third

class has the right to require that, if the vessel complies with all the requirements for a superior class, a statement to the effect that it belongs to that superior class shall be inserted in the safety certificate.

Vessels which are required to be fitted with a radiotelegraph installation shall be required, by the governments of the countries to which they belong, to maintain a continuous watch during navigation as soon as the said governments consider that it will be of service for the purpose of safety of life at sea.

Meanwhile, the contracting parties undertake to require, from the date of the ratification of the present convention subject to the delays specified below, a continuous watch on the following vessels:

(1) Vessels whose average speed in service exceeds 13 knots, which have on board 200 persons or more, and which, in the course of their voyage, go a distance of more than 500 sea miles between two consecutive ports, when these vessels are placed in the second class.

(2) Vessels in the second class, for the whole of the time during which they are more than 500 sea miles from the nearest coast.

(3) Other vessels specified in article 31, when they are engaged in the trans-Atlantic trade, or when they are engaged in other trades if their route takes them more than 1,000 sea miles from the nearest coast.

Vessels connected with all kinds of fishing business, including whaling, which are required to be fitted with a radiotelegraph installation, shall not be required to maintain a continuous watch.

The radiotelegraph installations required above shall be capable of transmitting clearly perceptible signals from ship to ship over a range of at least 100 sea miles by day under normal conditions and circumstances.

Every vessel which is required to be fitted with a radiotelegraph installation shall, whatever be the class in which it is placed, be provided with an emergency installation, every part of which is placed in a position of the greatest possible safety to be determined by the government of the country to which the vessel belongs. In all cases the emergency installation must be placed, in its entirety, in the upper part of the vessel, as high as practically possible. The emergency installation includes an independent source of energy capable of being put into operation rapidly and of working for at least six hours with a minimum range of 80 sea miles for vessels in the first class and 50 sea miles for vessels in the two other classes.

If the normal installation, which in accordance with this article has a range of at least 100 sea miles, satisfies all the conditions prescribed above, an emergency installation is not required.

Every master of a vessel who receives a call for assistance from a vessel in distress is bound to proceed to the assistance of the persons in distress.

Every master of a vessel in distress has the right to requisition from among the vessels which answer his call for assistance the vessel or vessels which he considers best able to render him assistance, but he must exercise this right only after consultation, so far as may be possible, with the masters of those vessels. Such vessels are then bound to comply immediately with the requisition by proceeding with all speed to the assistance of the persons in distress.

The masters of the vessels which are required to render assistance are released from this obligation as soon as the master or masters requisitioned have made known that they will comply with the requisition, or as soon as the master of one of the vessels which has reached the scene of the casualty has made known to them that their assistance is no longer necessary.

If the master of a vessel is unable, or considers it unreasonable or unnecessary, in the special circumstances of the case, to go to the assistance of the vessel in distress, he must immediately inform the master of the vessel in distress accordingly. Moreover, he must enter in his log book the reasons justifying his action.

Life-saving Appliances and Fire Protection

At no moment of its voyage may a vessel have on board a total number of persons greater than that for whom accommodation is provided in the lifeboats and the pontoon life rafts on board.

The number and arrangement of the boats, and (where they are allowed) of the pontoon rafts, on a vessel depend upon the total number of persons which the vessel is intended to carry; provided that there shall not be required on any voyage a total capacity in boats, and (where they are allowed) pontoon rafts, greater than that necessary to accommodate all the persons on board.

Each boat must be of sufficient strength to enable it to be safely lowered into the water when loaded with its full complement of persons and equipment.

Any type of boat may be accepted as equivalent to a boat of one of the prescribed classes and any type of raft as equivalent to an approved pontoon raft, if the administrations concerned are satisfied by suitable trials that it is as effective as the standard types of the class in question, or as the approved type of pontoon raft, as the case may be.

The government of the contracting party which accepts a new type of boat or raft will communicate to the governments of the other contracting parties particulars of the trials made. It will also inform them of the class in which a new type of boat has been placed.

Embarkation of the Passengers in the Boats and Rafts

Suitable arrangements shall be made for embarking the passengers in the boats.

In vessels which carry rafts there shall be a number of rope ladders always available for use in embarking the persons on to the rafts.

The minimum number of sets of davits is fixed in relation to the length of the vessel; provided that a number of sets of davits greater than the number of boats necessary for the accommodation of all the persons on board may not be required.

Handling of the Boats and Rafts

All the boats and rafts must be stowed in such a way that they can be launched in the shortest possible time and that, even under unfavorable conditions of list and trim from the point of view of the handling of the boats and rafts, it may be possible to embark in them as large a number of persons as possible.

The arrangements must be such that it may be possible to launch on either side of the vessel as large a number of boats and rafts as possible.

The davits shall be of such strength that the boats can be lowered with their full complement of persons and equipment, the vessel being assumed to have a list of 15 degrees.

The davits must be fitted with a gear of sufficient power to insure that the boat can be turned out against the maximum list under which the lowering of the boats is possible on the vessel in question.

Any appliance may be accepted in lieu of davits or sets of davits if the administration concerned is satisfied, after proper trials, that the appliance in question is as effective as davits for placing the boats in the water.

The government of the contracting party which accepts a new type of appliance, shall communicate to the other contracting parties particulars of the appliance with details of the trials made.

Means of Ingress and Egress—Emergency Lighting

(1) Proper arrangements shall be made for ingress to and egress from the different compartments, decks, etc.

(2) Provision shall be made for an electric or other system of lighting, sufficient for all requirements of safety, in the different parts of both new and existing vessels, and particularly upon the decks on which the lifeboats are stowed. On new vessels there must be a self-contained source capable of supplying, when necessary, this safety lighting system, and placed in the upper parts of the vessel, as high as practically possible.

(3) The exit from every compartment must always be lighted by an emergency lamp, which shall be kept locked, and which shall be independent of the ordinary lighting of the ship. These emergency lamps may be supplied from the independent installation referred to in the preceding paragraph, if an independent circuit is employed for this purpose and if this installation works concurrently with the ordinary lighting of the vessel.

Certificated Lifeboat Men—Manning of the Boats

There must be, for each boat or raft required, a minimum number of certificated lifeboat men. The minimum total number of certificated lifeboat men is determined by the provisions of the regulations.

The allocation of the certificated lifeboat men to each boat and raft remains within the discretion of the master, according to the circumstances.

By "certificated lifeboat man" is meant any member of the crew who holds a certificate of efficiency issued under the authority of the administration concerned, in accordance with the conditions laid down in the regulations.

Fire Protection

(1) The carriage, either as cargo or ballast, of goods which by reason of their nature, quantity, or mode of stowage, are, either singly or collectively, likely to endanger the lives of the passengers or the safety of the vessel, is forbidden.

This provision does not apply to the vessel's distress signals, nor to the carriage of naval or military stores for the public service of the State under authorized conditions.

(2) The government of each contracting party shall, from time to time by official notice, determine what goods are to be considered dangerous goods, and shall indicate the precautions which must be taken in the packing and stowage thereof.

(3) The following regulations indicate the arrangements to be made for the detection and extinction of fire:

1. A continuous patrol system shall be organized so that any outbreak of fire may be promptly detected.

2. Every vessel shall be provided with powerful pumps operated by steam or other means. On vessels of less than 4,000 tons there shall be two, and on larger vessels three of these pumps. The pumps shall be capable of delivering a sufficient quantity of water in two powerful jets simultaneously in any given part of the vessel, and shall be available for immediate use before the vessel leaves port.

3. The service pipes shall permit of two powerful jets of water being simultaneously directed on any given part of a deck occupied by passengers and crew, when the watertight and fireproof doors are closed. The service pipes and hoses shall be of ample size and made of suitable material. The branches of the pipes shall be so placed on each deck that the fire hose can be easily coupled to them.

4. Provision shall be made whereby both two powerful jets of water and a sufficient supply of steam may be conveyed to every space filled with cargo. Provision for the supply of steam need not be required in vessels of less than 1,000 tons.

5. A sufficient number of portable fluid fire extinguishers shall be provided, at least two being carried in each machinery space.

The governments of the contracting parties may accept other types of extinguishers provided that it is evident after trial that such extinguishers are as effective as the type referred to above. A government which accepts a new type of extinguisher shall send a description of the apparatus and particulars of the trial to the governments of the other contracting parties.

6. Two equipments, consisting of a smoke helmet and a safety lamp, shall be carried on board and kept in two different places.

7. All the fire-extinguishing appliances shall be thoroughly examined at least once each year by an inspector appointed by the government.

Muster Roll and Drills

Special duties for the event of an emergency shall be allotted to each member of the crew.

The muster list shows all these special duties, and indicates, in particular, the station to which each man must go, and the duties that he has to perform.

Before the vessel sails, the muster list shall be drawn up and exhibited, and the proper authority shall be satisfied that the muster list has been prepared for the vessel. It shall be posted in several parts of the vessel, and in particular in the crew's quarters.

Musters of the crew at their boat and fire stations, followed by boat and fire drills respectively, shall be held at least once a fortnight, either in port or at sea. An entry shall be made in the official log book of these drills, or of the reasons why they could not be held.

Different groups of boats shall be used in turn at successive boat drills. The drills and inspections shall be so arranged that the crew thoroughly understand and are practiced in the duties they have to perform, and that all the boats and pontoon rafts on the ship with the gear appertaining to them are always ready for immediate use.

General

This convention shall come into force on the 1st of July, 1915, and shall remain in force without any prescribed limit of time. Nevertheless, each contracting party may denounce the convention at any time after an interval of five years from the date on which the convention comes into force in that State.

This denunciation shall be notified through the diplomatic channel to the government of Great Britain, and by the latter to the governments of the other contracting parties. It shall take effect twelve months after the day on which the notification is received by the government of Great Britain.

A denunciation shall only affect the State which makes it, the convention remaining fully and completely operative as regards all the other States which have ratified it, or which have acceded thereto or which thereafter accede thereto.

This convention may be modified at subsequent conferences, of which the first shall be held, if necessary, in 1920. The place and time of these conferences shall be fixed by common consent by the governments of the contracting parties.

The governments may, through the diplomatic channel, introduce into this convention, by common consent and at any time, improvements which may be judged useful or necessary.

Material for Boston's New Dry Dock.—In deciding to build the immense new drydock, which forms part of Boston's port development, of reinforced concrete with wearing surfaces, or altars, of granite, photographs of reinforced concrete beams formed one of the determining features. These photographs showed that with proper mix and treatment the combined chemical and frost action of sea-water could be neutralized even when the material was subjected to alternate emersion under water and exposure to the air.

The New Allan Liner Calgarian

The Largest and Fastest Vessel Built for the Canadian Trade —Her Contract Speed Exceeded by 2¼ Knots on Trial

The quadruple-screw turbine mail and passenger steamer *Calgarian,* the largest and fastest vessel so far built for the Canadian trade, has been constructed for the Allan Line's main service between Liverpool, Quebec, and Montreal in summer, and Halifax and St. John in winter. The order for the hull and machinery was placed with the Fairfield Shipbuilding and Engineering Company, Limited, Govan, Glasgow. The vessel has been built to meet the requirements of the British Corporation Registry of Shipping, B. S.* class, also to Board of Trade and Canadian emigration rules.

New 18,000-Ton Passenger Liner *Calgarian* for the Canadian Trade

The massive appearance of the *Calgarian,* with cruiser stern, cruiser funnels, high pole masts and imposing superstructure, is seen in the photograph of the vessel given. She ran a series of speed trials on the Clyde March 16, when her best run was at a speed of 21.25 knots. The chief particulars of the ship are:

Length on waterline	590 feet 0 inch
Length between perpendiculars	570 feet 0 inch
Breadth, molded	70 feet 0 inch
Depth, molded to bridge deck	54 feet 0 inch
Mean draft	28 feet 6 inches
Gross tonnage	18,000 tons
Sea speed, designed	19 knots
Number of first class passengers	200
Number of second class passengers	500
Number of third class passengers	1,000
Number of officers and crew	500
Total number of passengers and crew	2,200

The propelling machinery consists of four turbines of the Parsons type, embodying the most recent improvements in design and construction, so as to ensure the maximum economy in fuel consumption, and resembling in this respect the machinery of the *Empress of Russia,* constructed recently at the same yard. The port outer shaft is driven by a high-pressure turbine, exhausting into an intermediate-pressure turbine driving the starboard outer shaft. The two inner shafts are each driven by a low-pressure turbine and they drive both ahead and astern. For maneuvering, when entering or leaving harbors independent high-pressure steam connections are provided on each low-pressure ahead turbine. There is also an independent high-pressure steam connection to the intermediate-pressure turbine. This, combined with an arrangement of valves, enables the high-pressure turbine to be cut out, or should the intermediate-pressure turbine be out of action, the high-pressure turbine can exhaust direct into either or both of the low-pressure turbines.

The whole of the main propelling and auxiliary machinery is situated in one watertight compartment. The turbine casings are of cast iron, and the drums, spindles, wheels and

shafting are of forged steel. The four propellers are of the solid bronze type and each has four blades.

The condensing plant, which is placed in a separate watertight compartment immediately aft of the main engine room, consists of two main condensers of the Uniflux type, which, together with the two air pumps of the Dual type, are designed to maintain a vacuum of 28½ inches with the barometer at 30 inches and a sea temperature of 75 degrees Fahrenheit. There are four centrifugal circulating pumps of Messrs. Pauls' make. The air pumps discharge to filters of the gravitation type, through which the feed water gravitates to large float control tanks placed near the center line of the ship, and suctions are provided for the main and auxiliary feed pumps.

The feed heater is of the high-pressure type, two Weir evaporators have a total capacity of 150 tons per twenty-four hours, and for four distillers have each an output of 20 tons per twenty-four hours.

Steam is generated in six double-ended and four single-ended cylindrical boilers placed in two boiler rooms and worked under forced draft on Howden's system, having a total heating surface of 54,250 square feet and a total grate surface of 1,344 square feet, designed for a working pressure of 200 pounds per square inch. There are four electrically-driven forced-draft fans, each 6 feet 9 inches diameter, placed on the deck above the boilers. Ash hoists and ash ejectors are arranged in each boiler room. The coal bunkers are situated alongside the boiler rooms, and there are also coal bunkers across the ship at the forward and after ends of each boiler room.

The main electrical generating plant consists of three steam turbine-driven sets, each of 250 kilowatts capacity, while as a stand-by in case of complete breakdown of the main plant a small emergency turbo generator of 18 kilowatts is installed on the shelter deck, well above the waterline. The total number of lamps throughout the ship is about 3,000.

The sliding doors in the main watertight bulkheads below the upper deck are worked by the Stone-Lloyd hydraulic arrangement, and can be operated from the navigating bridge if necessary. The steering gear is of Brown's quadrant rack and pinion type, and placed on the *G* deck. There is also auxiliary and stand-by steering gear.

Stockless anchors are provided and are worked by two separate engines of Napier's make, each engine driving one cable holder and one warping capstan. There are also four steam warping capstans on the *D* deck at the stern, all of Napier's make. There are ten steam winches for working cargo. The ship is ventilated on the "Nuvacuumette" system, the fresh air being heated in winter and cooled in summer, ensuring a temperature of 70 degrees Fahrenheit in the ship.

The refrigerating plant is of the CO_2 type by the Liverpool Refrigeration Company; the refrigerated spaces occupy about 70,000 cubic feet. This is in addition to the ship's refrigerated provision rooms, which have a capacity of about 10,000 cubic feet.

The ship has eight decks, *A* the boat deck, *B* the promenade, *C* the bridge, *D* the shelter, *E* the upper, *F* the main, *G* the lower, and *H* the orlop deck. There are eleven watertight bulkheads, and it is claimed that the ship will remain afloat with any four adjacent compartments open to the sea. The double bottom extends all fore and aft, and is carried to the upper turn of the bilge.

In addition to the usual light and sound signals and an installation of wireless telegraphy, there is submarine signalling gear, and a bridge semaphore with Morse flashing lamp on a platform above the bridge. In the equipment of the vessel there is provided a 7-knot motor launch equipped with wireless telegraphy apparatus. In case of fog this launch will be sent ahead scouting, but will be secured to the steamer by about 400 yards of light steel wire so that her position will always be known. Lifeboats are provided for all, together with a life jacket for each person on board. There are 17 ordinary lifeboats and 28 Englehardt decked boats.

The passenger accommodation is arranged on the *A, B, C, D, E* and *F* decks. The first class berths have been designed in suites, special cabins, one-berth and two-berth staterooms. There are four sets of *en suite* cabins, consisting of two bedrooms, sitting room, bath and dressing room; each sitting room has two large couches, a writing table, concealed wash basin and suitable furniture. There are eight special cabins with bath rooms adjoining; the paneling and furniture of these rooms is in oak.

The public rooms include a dining room on the shelter deck, a library, lounge, card room and smoke room on the bridge deck, and a verandah café, upper smoke room and gymnasium on the boat deck. The style of decoration is Georgian throughout. The dining saloon extends the full width of the ship and has seating accommodations for about 190 persons, all at small tables. There is a large dome overhead in the center of the room, with a gallery all round and a balcony at one end for the orchestra. The lounge is an example of the more sumptuous decoration, fashionable in the time of George II., and it contains a fine carved mantle-piece and overmantle. There is a painted frieze of dancing children which runs all round the central part of the room. The smoke room is in French walnut, the mantle-piece, with reproductions of an old Vauxhall-glass mirror, is somewhat similar in character to that in the King's Room at Hampton Court Palace. The gymnasium is a lofty room, and is equipped with all the latest appliances for health-giving exercises.

Accommodation is provided for second class passengers in two and four-berth rooms, furnished like the first class ordinary cabins, and having a large dining saloon, smoke room and lounge. The third class accommodation can be divided if required into two portions, so that either part can be placed in quarantine if necessary; a part of the third class space can be used for cargo purposes.

Externally the *Calgarian* resembles closely the Allan liner *Alsatian*, which was built by Messrs. Beardmore, Dalmuir, and described in our April issue of 1913. They are both of the cruiser stern design, but the rudders are not similar. The *Calgarian's* rudder is not supported outside the hull, while the *Alsatian's* rudder is hung on a single pintle in the stern post. The cruiser stern was severely tested during the turning trials of the *Calgarian*, and it earned unqualified approval because of its excellent qualities as regards freedom from vibration, ease of steering, and efficiency in propulsion. The ship turned a complete circle to port in 3 minutes 45 seconds, and a complete circle to starboard in 4 minutes 35 seconds.

The speed trials were run on the Clyde measured mile at Skelmorlie and consisted of seven double runs, beginning at a speed of 11 knots and working up gradually to a speed of 21.25 knots. On the last double run the mean speed was 20.63 knots, which is a knot and a-half more than that which will be required on regular service.

Lloyd's Quarterly Shipbuilding Returns.—The returns compiled by Lloyd's Register of Shipping, which only take into account vessels the construction of which has actually begun, show that, excluding warships, there were 535 vessels of 1,890,856 gross tons under construction in the United Kingdom at the close of the quarter ended March 31, 1914. The tonnage now under construction is about 66,000 tons less than that which was in hand at the end of last quarter, and nearly 173,000 tons less than that building in March, 1913.

The Watertight Subdivision of Ships and the Effect of Bilging

BY A. L. AYRE

The question of watertight subdivision in ships is one dealt with from two important points of view: First, technically, for the purposes of giving consideration to the intactness of the reserve buoyancy so as to minimize risk of foundering in the event of damage causing water to be admitted to the interior of the vessel, it being required that the quantity of water entering the vessel will be arrested at a certain point before the margin of reserve buoyancy has been consumed; secondly, commercially, for the purpose of giving cargo and passenger spaces within the boundaries of each compartment, of useful and economical length and capacity for the particular trade in which the vessel is to be engaged.

It will frequently be difficult to obtain ideal conditions in both cases, as it is quite apparent that a vessel so subdivided as to make her unsinkable after serious damage, may be one entirely uneconomical from a commercial point of view, owing to the fact that her cargo spaces may be too small and numerous, and consequently requiring separate hatchways and discharging appliances to each.

It is quite clear, however, that the benefit of any doubt should be given in favor of efficient watertight subdivision from the point of view of safety, and that in vessels designed to carry large numbers of passengers the question of safety should be the first to receive consideration. It will be interesting, first of all, to note how the buoyancy of a vessel is affected by bilging, also the condition of the vessel resulting therefrom. Fig. 1 shows a vessel floating in a normal condition at the waterline, *W. L.*, *G* being the center of gravity and *B* the corresponding center of buoyancy. The vessel being in equilibrium, these are vertically in line. Now, suppose the compartment *x, y, X, Y* to be bilged. The vessel will now lose the buoyancy of this compartment, which amount she must therefore recover by further immersion so as to regain the original displacement. The amount of mean sinkage is found by dividing the amount of lost buoyancy *x, y, X, Y* by the area of the intact waterplane, and for this purpose it is obvious that since none of the new displacement can be supplied between the bulkheads *X* and *Y*, this portion of waterplane area must therefore be left out of the calculation. The area of the intact waterplane will therefore be that contained between the points *W* and *x*, plus that contained between *y* and *L*.

Having obtained the amount of mean sinkage in this way it can be added on to the original mean draft, and the new mean draft is obtained, giving the waterline W_1 L_1, in Fig. 1. If the sinkage is only of small amount, the above result would be sufficiently accurate, but when it is large, the area of intact waterplane used for the final result should be a corrected one, taken at half depth of the layer of sinkage as previously found. This will allow for the vessel's change of form as immersion increases. It must be remembered, however, that should the damaged compartment contain cargo, an amount of buoyancy and area of waterplane, which will be contained in same, should be allowed for.

The vessel will not, of course, float at the new mean draft as found above, but will change trim according to the amended distribution of buoyancy resulting from the bilging of the compartment, because, although the new amount of buoyancy will be exactly equal to the former, the center of buoyancy will have altered so that the upward force will no longer be acting in the same vertical direction as hitherto. In Fig. 1 the new position of the center of buoyancy is shown by B_1, and this new position of the force of buoyancy acts with the force of gravity, as also shown, in such a manner as to cause the vessel to trim by the head and float at the waterline W_2, L_2. The question of change of trim will be dealt with later. A large amount of lost buoyancy causes a corresponding large amount of sinkage and probably also change of trim, and it is therefore seen that efficient watertight subdivision is essential so as to restrict the amount of buoyancy lost and the resultant detrimental consequences.

The main methods of obtaining watertight subdivision are:

1. Vertical transverse watertight bulkheads.
2. Vertical longitudinal watertight bulkheads.
3. Watertight decks and flats.
4. Double bottoms subdivided transversely and longitudinally.

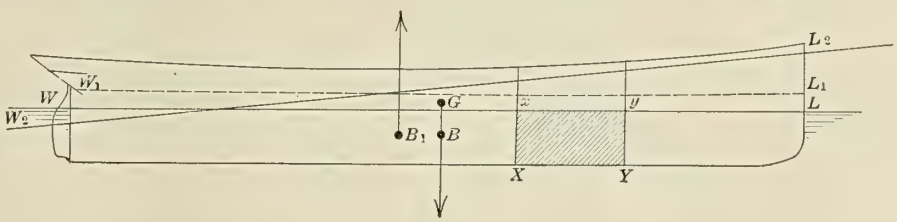


Fig. 1

The first and fourth are, as a rule, the only means adopted in cargo vessels constructed for bulk carrying, the general desire being to have as large and spacious holds as possible, and when for any reason it may be convenient to have small holds for any particular trade in which the vessel may be engaged, it is generally more convenient to erect temporary wood bulkheads to divide off the quantities of cargo as may be required.

It would be very difficult to give any idea of the proportion of cargo steamers, having four transverse bulkheads and engines amidships, which, with the largest compartment bilged, could be expected to remain afloat, but it would certainly not be a large figure or proportion. In the case of small coasting steamers with engines aft, and generally without double bottom, we frequently find vessels of a length of about 150 to 160 feet having a hold about 90 to 100 feet long, and it is obvious that in the event of such vessels being bilged in the hold space, which covers about 55 to 60 percent of the total length, and situated in the fullest and most buoyant portion of the ship, they would be unable to remain afloat except when laden with cargoes which would enable them to float waterlogged. In many vessels of this class, however, it appears that nothing can be done to improve their fatal condition in the event of such bilging; for instance, many of them are purposely designed with long holds and hatches to enable them to carry long lengths of shafting or telegraph poles, etc., and another transverse bulkhead would, of course, entirely prevent them being suitable for the trade in which they are required to work. It is imperative that in the case of a vessel liable to be placed in such a plight that the most rigorous attention be paid to life-saving appliances, especially with a view to assuring the rapid and safe launching of boats, etc.

Frequently the conditions of ordinary ocean-going cargo steamers are very little better; for instance, a vessel of the smaller class, say 280 feet long, with engines amidships and

having four transverse watertight bulkheads, may have a forward hold space equal in length to 35 or 40 percent of the total length of ship. Should such a vessel be bilged in the laden condition with a non-floatable cargo, it is obvious that she also must be in a serious predicament.

The following example of such a vessel will show this: The dimensions of the vessel are 280 feet between perpendiculars by 42 feet molded beam by 21 feet 6 inches molded depth and 18 feet 6 inches molded draft. The block coefficient is .8, giving a displacement, including shell, of 5,000 tons. Fig. 2 represents the vessel.

If the forward hold is bilged the amount of lost displacement shown by the shaded portion in the sketch is:

$$\frac{120 \times 42 \times 18.5}{35} \times .86 \text{ (coefficient of fineness of this portion)} = 2{,}291 \text{ tons.}$$

It must be remembered, however, that this is not the correct amount of buoyancy, because within the shaded portion there is situated some cargo and structure which itself provides some buoyancy, owing to the fact that it prevents the water from occupying the whole of the space. In the case of a compartment filled with coal, water can find access to about 40 percent of the space. To allow for cargoes of greater density than coal a reasonable figure to take is 50 percent. In the above case the amount of hold space in way of the displacement represented by the shaded portion is 75,000 cubic feet, and in view of the above we can take half of this as being buoyant when bilged.

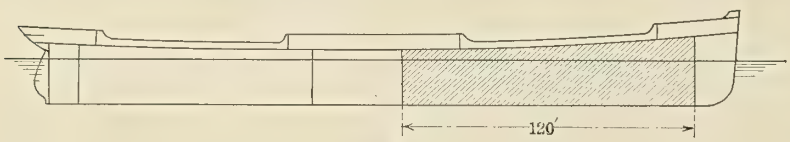


Fig. 2

$$\frac{75{,}000}{2} \times \frac{1}{35} = 1{,}071 \text{ tons, then } 2{,}291 - 1{,}071 = 1{,}220 \text{ tons,}$$

net loss of buoyancy.

The area of the intact waterplane divided by 35 will give the "tons per foot," and the amount of lost buoyancy being then divided by this will give the amount of sinkage in feet.

Total area of waterplane $= 280 \times 42 \times .9 = 10{,}584$ square feet. A deduction must now be made for the waterplane area in way of the bilged compartment, and allowance must here again be made in respect of the cargo lying in way of same, which, since it provides buoyancy, will also provide waterplane area. The amount of area provided will be in the same proportion as previously taken for buoyancy in way of cargo, *i. e.,* 50 percent. The amount of waterplane area which is lost in way of the bilged compartment is therefore $120 \times 42 \times .95$ (coefficient) $\times$ 50 percent $= 2{,}394$ square feet. The net area of intact waterplane now becomes $10{,}584 - 2{,}394 = 8{,}190$ square feet.

The "tons per foot" displacement at the load waterline in the damaged condition will be $8{,}190 \div 35 = 234$ tons.

The extent of the *mean* sinkage owing to the loss of buoyancy in the damaged compartment is found by 1,220 tons, net loss of buoyancy $\div 234 = 5.2$ feet.

Original load draft = 18.5 feet molded
+ mean sinkage = 5.2 feet

23.7 feet = mean draft in damaged condition.

Since the molded depth of the vessel is only 21 feet 6 inches, it is seen that the mean draft in the damaged condition is greater than this by 2.2 feet; but it must be remembered that in obtaining this new mean draft we have not allowed for the change in the amount of "tons per foot' which occurs after the deck becomes immersed, *i. e.,* when the buoyancy remaining is that contained in the sheer and in the poop, bridge and forecastle.

In the above example about 1,350 tons of displacement are contained in the hull proper above the load line and up to the deck including the sheer, this, together with the load displacement of 5,000 tons, making in all 6,350 tons. The 1,350 tons of reserve is equal to about 21 percent of the total amount, while for a vessel of this molded depth the British Board of Trade tables require 27.3 percent. The difference in the example is, of course, taken as being made up in the erections, and, as a matter of fact, in the case taken it is more than made up if the erections are taken at the normal height of 7 feet, and as being perfectly watertight, as the percentage of reserve buoyancy then actually works out at a little over 31. The additional buoyancy contained in the erections is about 918 tons on this basis.

In the actual circumstances, however, 1,350 tons of reserve buoyancy does not exist in the hull proper, as there is a total of about 680 tons contained within the damaged compartment, and if only 50 percent of this, *i. e.,* the buoyant value of the cargo, is taken, the net amount of reserve buoyancy will then become $1{,}350 - 340 = 1{,}010$ tons.

The net loss of buoyancy being 1,220 tons, it is seen that even with the whole of the hull immersed there is still a further amount of 210 tons required to be made up by the erections.

Seeing that these erections are rarely intact as regards watertightness, it is at once seen that little likelihood remains of there being sufficient reserve of buoyancy to balance the amount which has been lost in the bilged compartment. The large change of trim and the loss of transverse stability, both of which will also occur, will further jeopardize the vessel, and it is quite clear that she cannot by any means be expected to remain afloat, and it is also seen that a vessel with the bulk of her reserve buoyancy contained in the hull proper, instead of depending largely upon the amount being made up in the erections, will be a much safer vessel, even comparing with a case in which the erections are perfectly watertight.

The number of bulkheads are generally determined by arranging them in such positions that no compartment will exceed a certain maximum length, or to determine the number in accordance with the length of ship. While in purely cargo vessels such methods may give, as it were, a compromise in the consideration of watertight subdivision from the safety and commercial points of view, they should not be *tolerated* in passenger ships as a means of determining their subdivision.

In the latter cases the spacing of bulkheads and other means of watertight subdivision should be such that will provide safety together with a margin when a certain percentage of length is flooded, this percentage of length being reasonably large, and, of course, having further subdivision within itself so as to minimize the effect of the bilging as far as possible. As seen in the foregoing example, and in the case of single-decked vessels, or other vessels without a watertight lower deck, it could not, of course, be expected that in ordinary cases a laden vessel with 40 percent or more of her length exposed to the sea, could remain in a floating condition, and it appears, therefore, that the aid of the watertight lower deck, while not limiting the extent of flooding longitudinally, will, as a rule, do so vertically, and thereby reduce the amount of flooding and enabling the buoyancy lying above same to be preserved intact. A watertight lower deck in passenger vessels will therefore be a substantial advantage and a most valuable asset on the side of safety.

(To be continued)

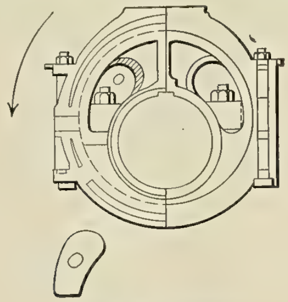
Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Repairs to a Broken Eccentric at Sea

The go-astern eccentric is keyed to the shaft and its position is fixed and permanent. On the other hand, the go-ahead eccentric is not keyed to the shaft, but is driven by the go-astern eccentric, a bolt passing through both eccentrics for this purpose. This bolt is a driving fit in the go-astern eccentric, but passed freely through an opening in the go-ahead eccentric. This space around the bolt allows for adjustment to increase or decrease the angular advances of the eccentric at will.

After the go-ahead eccentric is adjusted to the desired position the place around the bolt is filled in with hard wood



Sketch of Repairs

blocks and the nut is put on and set up tight. In one instance these blocks of wood became loose and crumbled, allowing the bolt to swing back and forth in the slotter opening, breaking the arm or the rib of the eccentric.

Repairs were made in this case by fitting a strap of half-inch boiler plate between the rib or arm of the eccentric and the part where the two halves of the eccentric are bolted together, securing the strap in place by the nut of the driving bolt. The strain of driving the eccentric then came on the metal where the two halves of the eccentric were joined.

Philadelphia, Pa. J. E. C.

Corrosion of Boilers through the Use of Sulphurous Oils

On several occasions the excessive corrosion of boilers using oil-fuel having a high sulphur content has been noted in current engineering literature. Since many seen to be quite unable to account for this corrosion, I believe that this letter setting forth what I believe to be the correct theory will be of interest. Needless to say, this thory is not entirely original, so many may be acquainted with some part of it.

The following extract is quoted from Technical Paper No. 26, Bureau of Mines: "The corrosive action of sulphur acids on fireboxes and boiler flues, and on the cylinders of internal combustion engines, is not thoroughly understood. The effects of such action are sufficiently evidenced by the pittings, scales, and roughened spots on metal surfaces that have been exposed to the products of combustion of fuels rich in sulphur. Therefore an exact knowledge of the sulphur content of fuels is desirable."

Reference to Bulletin No. 19, of the same Bureau, will give one that exact knowledge of many of the California oils. For the purposes of discussion these are as suitable as any. On the average, the West coast oils are quite rich in sulphur. An examination of the analyses given in the above-mentioned bulletin (oils of the San Joaquin Valley of California) shows a sulphur content varying from .12 percent to 1.32 percent. The average sulphur content of the oils of this vicinity seems to be about .8 percent. This may seem small to many, but if one will remember that for every ton of fuel burned there is also burned, approximately, 18 pounds of sulphur, he will see that the weight of sulphur burned in a large furnace, in the course of a few days or weeks under steam, will mount to rather astonishing figures.

The sulphur existing in the liquid fuel is burned with the oil as it passes into the furnace. When sulphur burns, in air or in oxygen, it unites with oxygen, forming a large amount of sulphurous oxide (SO_2) and a small amount of sulphuric oxide (SO_3). Both of these gases are colorless and therefore cannot be detected by observation. Each of them can have a corrosive effect on such metal as it may come in contact with, while passing through the boiler.

At high temperatures, in the absence of air, iron dissolves in SO_2, forming ferrous sulphite ($FeSO_3$). It is therefore quite probable that this reaction may go on to a slight extent at furnace temperatures, and since large quantities of SO_2 are present, this may cause marked effects in the course of time.

Under favorable conditions SO_3 unites with iron to form ferrous oxide (FeO). It is, however, quite improbable that this reaction takes place to any extent, on account of the great dilution of the SO_3 in the products of combustion.

As the effect of a slight covering of soot on the tubes would greatly reduce any reactions from the above causes, it is with the further products formed by the SO_3 that we are principally interested, since it is from this source that the chief cause of trouble originates.

When formed, the SO_3 is in the gaseous state. At 46 degrees C. (114.8 degrees F.) it condenses to a liquid, and at 14.8 degrees C. (58.6 degrees F.) it solidifies into a white wax-like solid. As a matter of course, the temperature of the products of combustion will not get as low as 46 degrees C. while the boiler is under steam, therefore the SO_3 will remain as a gas during this time.

It seems to be an established fact that gas is occluded, that is, absorbed and retained, by firebrick, porous lagging, etc. This is not at all surprising, since many substances possess truly remarkable powers of occluding large quantities of gas. In the case at hand, I believe that the porous substances in the boiler, that is, firebricks, baffling, and lagging, absorb and retain large quantities of SO_3. Some small part of this gas may be given off as the boiler cools, but, since occluded gases are not easily given off, the greater part of the gas will remain in the absorbing medium.

As soon as the temperature falls below 46 degrees C. the contained SO_3 will become a liquid, and, having a specific gravity of approximately 1.94, will tend to flow toward the lower part of the absorbent. If the temperature continues to fall, the SO_3 will solidify at 14.8 degrees C.

In either the liquid or the gaseous form, the SO_3 unites readily with water to form sulphuric acid, according to the following equation:

$$SO_3 + H_2O = H_2SO_4.$$

Since, ordinarily, water vapor can always be found in the combustion spaces of a dead boiler, an ample supply of water is easily forthcoming by the condensation of the water vapor on the metallic surfaces. The product is then a dilute sulphuric acid.

Dilute sulphuric acid is a most active reagent with iron of any kind, uniting with it to form ferrous sulphate, as follows:

$$H_2SO_4 + Fe = FeSO_4 + H_2$$

The ferrous sulphate thus formed is in the form of green crystals and should be easily detected upon a critical examination of a corroded part. The compound thus formed is composed of .3675 parts of pure iron to .6325 parts of other elements; that is, it is more than one-third pure iron. From this it is easily seen that a small quantity of the sulphate may indicate serious pitting if the action is localized. In all probability, action from this cause will be extremely local, usually taking place at such places as the absorbent materials are in contact with metallic surfaces, more especially when this contact is near the bottom of the absorbing material.

If it is desired to test either scales scraped from a metallic surface or pieces of firebrick to determine whether or not sulphuric acid or sulphates are present, scrapings or small pieces of the bricks should be put in a small quantity of distilled water and allowed to remain there a few minutes. After the soluble matter is dissolved, the liquid should be separated from the solid matter either by filtration or by decantation; that is, by allowing the solids to settle and then carefully pouring off the liquid. A few drops of barium chloride ($BaCl_2$) should now be added. If either sulphuric acid or ferrous sulphate is present in the solution, a dense white precipitate of barium sulphate will immediately appear. This is a very sensitive, quick, and satisfactory reaction.

As a means of preventing further trouble from this source, the following suggestions are made, both of which are quite apparent. First, keep the boiler dry when not in use, since the acid cannot be formed without water. Just how completely the formation of acid can be prevented by careful attempts to keep out moisture remains to be demonstrated by experience. Second, sprinkle ordinary lime, either quick or slaked, upon the troubled areas, after the boiler has cooled. Such acid as may come into contact with the lime will be neutralized, without damage to the iron. W. W. B.

Serious Accident Due to Shortness of Water

To all marine engineers the boilers are the most important section of their department, and it cannot be too deeply impressed on the minds of those in charge the serious results that may be incurred by the neglect of the water gage glass, and that a large proportion of boiler troubles are caused by shortness of water. The writer's experience showed that in one case, anyhow, a serious accident would have been averted had proper precautions been taken in the first instance.

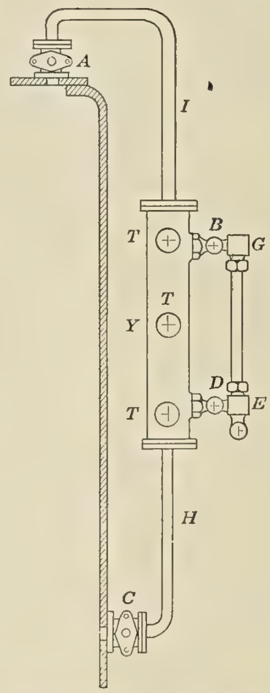
We were about to leave Cardiff on a voyage down the Mediterranean and Black Sea ports, when our fourth engineer (who, by the way, was continually growling about the misery of a marine engineer's life) failed to show up on the morning of sailing, so we either had to go to sea short-handed or else seek a substitute. The latter course was favored by the chief engineer for obvious reasons, so our own donkeyman, who was a trustworthy man, but did not hold any certificate or license, was engaged.

After a couple of four-hour watches, in which the chief helped the donkeyman out, he was left to go below alone, in sole charge of the engines and boilers. I myself had to relieve him at midnight and all was well.

One night several days out, however, about 11 P. M., I was aroused from my meagre slumbers by a terrific noise as of escaping steam somewhere in vicinity of the fire room, which caused me to dress hastily and rush from my berth. At the top of the fiddley grating I was met by an oiler who acquainted me with a hurried explanation of the explosion. He said the starboard boiler's high furnace had burst.

Proceeding down the ladder to the stokehold, I saw the chief, second, and some firemen attempting to close the starboard boiler stop valve and auxiliaries. The heat was intense on the tops of the boilers, and I remember the top button of my boiler suit burned my chin when it came in contact with it, raising a blister. It was useless to attempt putting water into the boiler, as the combustion chamber top had collapsed and was down about 4 inches, the nuts stripped off eight of the staybolts supporting it, and six of them were drawn through the plate, leaving six 1½-inch diameter holes through which the steam escaped with great violence, the pressure carried being 180 pounds per square inch.

There was no doubt that the boiler became short of water, the combustion chamber crown plate was overheated and was drawn over the ends of some of the supporting stays. Our erstwhile fourth engineer swore there was plenty of water



Arrangement of Water Column

in the starboard boiler, and upon examination this proved to be incorrect, although the glass was full. The trouble lay in the top double shut-off cock or valve becoming choked with deposit, allowing the gage glass to fill up.

The test cocks on marine boilers in the writer's experience have usually been for ornamentation, as they are packed tight to prevent leakage, and difficult to open, so consequently never touched. Now, to help junior engineers who are not fully conversant with the methods of testing water gages, I propose to give a short, reliable way to ascertain if all pipes, cocks, valves, etc., on gage columns, etc., are clear.

To blow glass through shut B and D alternately and keep E open, but to blow through the water gage it is necessary, after blowing through the glass, to shut A and C alternately, at the same time keeping B, D and E open long enough to completely discharge the contents of the gage and its connections. Suppose A is choked, assuming B, D and C are clear. The steam in the column and in the pipe I becomes condensed, and the water flowing through C to take its place rises in column Y and in the glass to a level higher than the water in the boiler. This means a false level. It we now open E and water is blown out, then on E being closed again the water will rise higher again than before misleading the engineer further.

When B, D and A are clear and C choked, then any water that may be in the glass is trapped and no longer rises and falls with the water in the boiler, or with the motion of the ship. It will, however, rise in the glass, owing to the con-

densation of the steam in the upper part of the gage until *E* is opened, when all the water in the glass is blown out. On closing *E* the glass shows no water, although the water in the boiler may be at the working level.

When the test cocks *T*, *T*, and *T* are attached to column *Y*, they cease to be reliable when either double shut-offs *A* or *C*, or the pipe in connection, is choked or partially so.

Woodbridge, N. J. F. W. CHRISTIANSEN.

Securing a Loose Piston

Quite recently, while running at about 180 revolutions per minute, approximately fifteen knots, a very loud, sharp knock was heard in the vicinity of the starboard after low-pressure cylinder. This knock was so distinctly metallic that it was known at once that something had come adrift. The engine was immediately stopped, and all crank and crosshead bolts and nuts examined. All were found tight. However, when the engine was slowly started again, the same knock continued.

Both engines were then stopped. The jacking gear was thrown in on the starboard engine, after which the port engine was slowly worked up to speed. The starboard engine was jacked over until the low-pressure piston was at the top of its stroke. As a matter of precaution, blocking was put in, between the lower cylinder heads and the crossheads, wherever the dragging propeller tended to make the crossheads rise. By securely wedging these short shores, a small part of the strain was taken off the jacking gear.

As soon as the cylinder was sufficiently cool to allow work to proceed, the after low-pressure cylinder head was removed. Investigation showed that the piston nut had backed off about a quarter of an inch, and that everything else was apparently in good condition.

An attempt was made to set up on the piston nut, but this was not successful. It was soon found that the threads had been so jammed, by the pounding of the piston, that the limit of travel of the nut was only about one-half of a turn. This gave about a quarter of an inch vertical motion.

Since the vessel was only about seventy-five miles from the end of her run, it was decided to try quick repairs, as an experiment, without any thought of having them hold longer than necessary to finish the trip.

For emergency repairs, three horseshoes were cut out of heavy sheet lead. After backing the nut off as far as possible, the lead horseshoes were slipped into place between the top of the piston and the nut. In each case the horseshoe was somewhat closed by bending in the long points, thus making almost a complete ring. These three rings made a snug fit, practically filling the entire opening. The nut was then set up, using a heavy maul, until it was quite firm. The cylinder head was replaced, and, after removing the jacking gear, shores, etc., the engine was started at moderate speed.

By keeping the auxiliary exhaust out of the low-pressure cylinder, so that the temperature remained quite low, it was hoped that these lead rings would stand the compression to which they were subjected, until arrival in port. The engine did run it, but by the time of arrival in port it was pounding quite badly.

After arrival in port, the cylinder was again opened and the temporary lead rings removed. Needless to say, some small bits of lead were adrift in the cylinder, but they were not large enough to cause any trouble.

Two horseshoes, having long points, were then cut out of sheet steel. They were only roughly finished, but were made to be a good fit for the upper end of the piston rod. These horseshoes were slipped into place, after the nut had been backed off, and the ends were bent down so as to catch on the side of the boss on the piston. This preliminary bending kept them from working out when the nut was set up. The nut was then set up with great force; in fact, to what we believed to be about its limit of travel without rupture. After this, the points on the horseshoes were well hammered down and the cylinder was closed as usual.

This engine was put into service the next morning, after which it ran, without trouble, until opportunity offered for making permanent repairs. It was operated at speeds as high as 220 revolutions per minute without showing any signs of working loose around the repairs described.

Although, in this case, sheet lead gave fair results for a very temporary job, it certainly is not to be recommended for any such work, since it is far too easily flattened by the pressure necessary to get much work out of that cylinder. As soon as the job gets sufficiently loose, so that the lead receives a blow each stroke, the repairs very quickly go to pieces. It should also be remembered that this was the low-pressure cylinder of a triple-expansion engine, and therefore working at a comparatively low temperature. In a cylinder in which the working heat is high, I do not believe that such a repair job would give sufficient satisfaction to justify its installation. This kind of a job was used here only because the run would have been finished before any other repairs could have been made, and because it was believed that it would hold sufficiently well to allow the engine to be used while working around the docks.

When permanent repairs were made it was found necessary to split the nut in two places before it could be removed. The threads on the piston rod were found practically uninjured, while those in the nut were badly jammed and partially stripped. A new nut was made and installed, thus completing repairs. W. W. B.

Friction

Friction is defined as the resistance to sliding, which is experienced when one body slides over another. A well-known text book on physics says "Friction is no doubt due to interlocking of the projections on one surface with those on the other surface."

There is a rather widespread conviction among engineers that the above statement accounts for friction, but a moment's consideration will show that friction cannot be entirely due to the above cause. The second law of friction states that "Friction is independent of the area of the surfaces in contact, for any given normal pressure, i. e., it is independent of the intensity of the normal pressure." Now, if friction were due to the interlocking of the projections, it will be seen that friction will become dependent on the area of the bearing surfaces in contact, which is in direct opposition to the second law.

Again, with interlocking of the projections, when one surface slides over another we would get abrasion of the surfaces taking place and the laws of friction would not hold. If the two bodies were perfectly smooth, there would still be a certain amount of resistance to sliding, hence it would seem that friction is really due to molecular cohesion of the particles of each surface.

The reasons in support of this theory may be indicated as follows: Matter is composed of molecules which attract one another with tremendous forces. These forces, however, are only sufficient to hold each particle of the body together through an infinitely small distance. When a bar of iron, say, is broken in tenison and the two broken ends fitted together again, the application of sufficient force to bring the two portions close enough together would cause the pieces to reunite to form a solid bar. Of course it is impossible from practical considerations to join up a broken bar by this means, but a similar case is found in the forming of powdered graphite into a solid block by the application of pressure.

These molecular forces, however, will be partly felt at the small distances attainable in practice, hence the theory that friction is due to molecular cohesion of the particles would seem to have some weight. "ISON."

Marine Articles in the Engineering Press

Commercial Importance of the Panama Canal.—By Emory R. Johnson, Ph.D., Sc.D. In this paper the author shows the commercial importance of the Panama Canal, or the assistance it will render industry and the trade of the people of the United States and other countries, first by showing what effects the new route will have upon the length and time of ocean voyages, then by stating conservatively the volume of shipping, foreign and American, international and coastwise, that may be expected to use the canal. Estimates are given to show the influence which the Panama Canal will have upon the freight rates by rail between the two seaboards of the United States and by ocean carriers engaged in the American intercoastal and foreign commerce. Other points covered are fuel costs, in which the author points out how much the ocean carriers will save in fuel costs by using the Panama route, and how the cheaper fuel costs by way of the Isthmus will assist the Panama Canal in competing with alternative routes via the Straits of Magellan, the Cape of Good Hope and the Suez Canal. Finally, the relation of tolls to the traffic and revenues of the canal is analyzed. 9,100 words.—*United States Naval Institute Proceedings*, December.

The Story of the Orient Line.—Unlike most of the large British steamship companies, the Orient Line came into existence with a few chartered steamships with which a new line was established in 1877 between England and the Australian colonies over the long sea route around the Cape of Good Hope. This line was established without government assistance, and gradually increased its activities with the addition of new and up-to-date vessels, and with the introduction, from time to time, of new innovations, such, for instance, as the provision of refrigerated space in their vessels. The latter innovation was made in 1880, and from this beginning there sprang the huge business in meat, perishable produce and fruit which now exists between the commonwealth and the mother country. At about this time, the Cape route was deserted for that through the Suez Canal and Red Sea to Colombo. The establishment of regular schedules, with speedy up-to-date vessels, soon acquired for the company a share in the mail contracts, of which the company continually took advantage, as, for instance, when in 1908 the Post-Office insisted, among other things, upon the provision by the contractors of a new fleet of 12,000-ton vessels, a condition which the Orient Company readily met. The Orient Line has never engaged its ships in any other regular service than that to Australia. The main source of its activity, outside the mail service, has been the tourist business, to which this company was one of the first to give serious attention. 9 illustrations. 2,800 words.—*The Marine Engineer and Naval Architect*, January.

Considering Trim of Ship on Design of Lines.—It is pointed out that modern demands for certain predetermined qualities of the ship are much greater now than formerly, and that frequently trim, say for light or ballasted conditions, has to be estimated at the time of the design of the lines. The starting point is said to be the center of gravity for different drafts and conditions, thereby also determining the position of the center of buoyancy fore and aft. From trimmed conditions it is possible to advance to the center of buoyancy for level keel conditions by estimating the longitudinal metacentric radius, and with the proper trim angle the horizontal shift of the center of buoyancy it is assumed that the vertical displacement scale, the curve of waterline areas and therewith the vertical position of the centers of buoyancy are given. Finding as above outlined the horizontal position of the centers of buoyancy and entering them to scale in their actual positions on the curve sheet, then the actual horizontal positions of the water planes are shown to be the intersections of the waterlines with tangents through the respective center of buoyancy to the whole curve of actual centers of buoyancy. The area of the water planes being given, and its individual center of gravity being found, no difficulty is experienced in laying down the lines according to the requirements. 4 illustrations. 1,140 words.—*Schiffbau*, January 28.

German River Shipping in 1913.—The greater regularity of the volume of the German river shipping is explained, although statistics depend a little uncertainly upon a census taken only every five years, except on the Rhine, where a registered society issues a fairly complete list of river vessels. The information on river and canal tonnage was somewhat inaccurate up to 1912, but in 1913 the "Central Association of German River Shipping" issued quite an accurate register. It states that 1,196 river vessels of 266,386 tons carrying capacity were built, the total accounting for more ships but less tonnage than in 1912. Of this Holland shipyards furnished seventy-two vessels of 43,634 tons for German account, a competition very distasteful to many interests of the region of the lower Rhine. To offset this, financially, it is recorded, with satisfaction, that some of the German Rhine shipyards built a considerable number of high-grade vessels for foreign account of higher value than the addition from Holland yards. The Rhine district shows a reduction of tonnage against 1912, but an increase in steam and motorship horsepower. In the Ems district there is a reduction of almost one-half recorded. In the Weser and Oder districts the barges built were of practically the same tonnage, while steamer and motorship building was materially reduced. In the Elbe district tonnage decreased but the horsepower of steamers increased. In the Eastern districts the tonnage remained practically constant. 1 table. 1,320 words.—*Schiffbau*, January 28.

Tariff, Percentage or Trust in Shipbuilding.—A full discussion of the economic conditions is given, under which the leading incorporated German shipyards are so severely handicapped that they pay either no dividend at all or at least only an unsatisfactory one. Only one large private yard is on a satisfactory financial footing. A number of remedies are discussed, taking up in turn the questions whether help could be expected from a brighter future, more extended credit from the banks or special orders and assistance from the government. But only three measures for the betterment of the financial conditions are estimated as worthy of serious consideration, namely, a tariff on all ships built in foreign countries, a percentage agreement on builders' profits and a trust for regulating prices. The first possibility, a protective tariff on ships, whether directly levied or in form of rebates on harbor dues or railroad freights to home vessels, or increased taxes on foreign flags or tonnage is, however, considered of doubtful value, as seagoing shipping must compete in the international market with all nations and a tariff would be a severe handicap. The second possibility deals with agreements between builders and owners of ships upon a fixed percentage of builders' profits on and above the actual cost of the vessel, pointing out, however, that this would reduce the shipyard more or less to a subordinate employee of the owner and be seriously dulling the ambition and incentive of the shipyard to produce work at the minimum cost. A number of such firms are mentioned, among them being in the United States the Standard Oil Company and the Great Northern Railroad, who are stated to own shipyards in Camden and

New London. The third possibility is that of a trust of all, or at least all, large shipyards, which is intimated would prove a very satisfactory solution of the question of insufficient earnings. It is assumed that the management of the syndicated shipyards would not increase the price on merchant ships that have to compete in the international freight market, but on the giant passenger liners and on warships. It is suggested to increase prices, because, in the first place, a wealthy patronage could bear increased prices, and, in the second place, the government and the entire taxpaying community could carry the burden without feeling it. 3,500 words.—*Schiffbau*, February 11.

Oil Tanker Jupiter.—The tanker *Jupiter* was launched in January at the Howaldt Works near Kiel for the German-American Petroleum Company in Hamburg. She is not only the largest single-screw steamer ever built, but also the largest tanker, exceeding by about 2 feet beam similar English-built tankers. She is 525 feet long by 68 feet 6 inches molded beam, by 41 feet 9 inches depth by 26 feet 6 inches draft, and of about 15,000 tons carrying capacity. She is built as a shelter-deck vessel under the highest class of English Lloyd's, after the longitudinal system of framing with the propelling machinery in the stern. There are seventeen transverse bulkheads, and the hull is divided into twenty oil compartments, bound by cofferdams at the ends with the pump room in the middle. An expansion tank, 41 feet wide with summer tanks at the sides, extends over the entire 295 feet 3 inches length of the tanks. To balance the engine weight a package freight cargo hold and a ballast or oil tank are provided forward. The pumping plant consists of two horizontal duplex steam pumps of 430 tons per hour capacity and a large turbo-fan for removing the gases. The engine plant consists of one four-cylinder engine of 3,500 indicated horsepower at 72 revolutions per minute, giving the ship a speed of 10½ knots; the cylinders are 27.2, 40, 57.1 and 81.3 inches diameter by 40 inches stroke. One air pump, two feed, two bilge, one sanitary and two evaporator pumps are driven from the crossheads. There are three single-ended boilers, 15 feet 5 inches diameter by 11 feet 6 inches long, fitted with Howden's draft and built for 220 pounds pressure per square inch. The total heating surface is 8,611 square feet and the grate area 194 square feet. The fuel is coal. A donkey boiler, with 1,345 square feet heating surface and built for 125 pounds pressure, is fitted. The transverse coal bunker being oil-tight is fitted also for oil fuel. The engine crew is berthed aft, while the captain and officers are in the forward deckhouse, with the crew in the forecastle. All staterooms have electric light and steam heat. The auxiliaries include one steam windlass, one cargo winch, one mooring winch aft and a steam steerer. Two masts support a wireless telegraphy outfit, and there is also an apparatus for under-water sound signals. 2 plates. 1,270 words.—*Schiffbau*, January 28.

Fuel Oils: Their Origin, Production and Treatment.—By Dr. David T. Day. This article is adapted from lectures delivered in the Post Graduate Department of the United States Naval Academy in February, 1913. It is divided into three chapters dealing with the conditions of occurrence of petroleum, the production of oil and the treatment of oils. Each subject is adequately treated and the article leads up logically to a discussion of the kinds of oil suitable for fuel oils in naval vessels and for use in internal combustion engines, as well as the available supply of such oils. 11,500 words.—*United States Naval Institute Proceedings*, January-February.

S. S. Cap Trafalgar.—The *Cap Trafalgar,* luxuriously fitted as a passenger steamer, has just been completed by the Vulcan Works, Hamburg, for the Hamburg-South American Company. She is 593 feet long and 72 feet beam, with a gross tonnage of 18,000. Propulsion is by two sets of 4-cylinder triple-expansion engines of 6,000 horsepower, each exhausting into a Parsons low-pressure turbine of 7,000 horsepower, driving a center screw. The reciprocating engines run normally at 86 revolutions per minute and the turbine at 210 revolutions per minute. Steam is furnished by Yarrow water-tube boilers, the coal being trimmed by a novel arrangement of vacuum pumps. 6 illustrations. 1,650 words. *The Engineer,* March 20.

Turbine versus Reciprocating Engines for Marine Propulsion.—After discussing the merits and demerits of each type of machinery the author concludes that the turbine is undoubtedly superior to the reciprocating engine as regards economy at high powers, and is therefore almost universally installed on warships, where great speed is required. It is considered, however, that the ideal ngine for high-speed warships will be the combination of turbine and reciprocating machinery on account of the gains in economy made at cruising speeds. In high-speed merchant vessels the turbine is found superior, while in moderate-speed vessels either combination machinery, geared turbines or straight reciprocating engines using superheated steam find favor. 2 illustrations. 3,700 words.—*The Marine Engineer and Naval Architect,* April.

H. M. Battleship Queen Elizabeth.—The superiority of the *Queen Elizabeth* in gun power, speed and defensive power over all other battleships afloat is discussed at some length, and then the full particulars of the vessel in comparison with the latest battleships of other nations are given. The *Queen Elizabeth* is 650 feet long, 94 feet beam, and 27½ feet draft. On a displacement of 27,500 tons she carries eight 15-inch guns in four turrets on the centerline of the ship protected by 14-inch armor, and sixteen 6-inch guns behind 8-inch armor along the upper deck and in the superstructure. The main waterline armor is 13½ inches thick, reduced to 10 inches and 8 inches in the strakes above and to 6 inches at the ends. A speed of 25 knots is obtained by Parsons turbines of 58,000 horsepower driving four screws. Steam is supplied by oil-fired Babcock & Wilcox boilers, the bunkers having a capacity of 4,000 tons. 2 illustrations. 2,200 words.—*The Marine Engineer and Naval Architect,* March.

Emergency Repairs to a Destroyer.—By Lieutenant Commander J. F. Hellweg, U. S. N. During the maneuvers off the coast of Cuba last winter the U. S. S. *Burrows* had her bow twisted to port about 80 degrees and badly crushed in collision. The port plating was so badly crushed and distorted that it had to be discarded. The bow was undercut by the blow and the forecastle pulled down and to starboard by the sharp twist of the stem. The vessel returned to Guantanamo Bay under her own steam and was laid alongside a dock for repairs. She was lightened forward to bring her bow out of the water, but it was found necessary to run her bow up on a small marine railway to reach the break in her keel. With the aid of air tools obtained from other ships of the fleet the damaged parts of the bow were removed, straightened and replaced. The forward frames were so badly mangled, however, that they had to be discarded and a makeshift repair resorted to, consisting of oak stringers and breasthooks embedded in cement and secured by through bolts. The entire work was done by members of the crew in 91 working hours, enabling the vessel to resume service under normal conditions. Complete details of the repairs are explained with the aid of photographs and diagrams. 12 illustrations. 2,800 words.—*United States Naval Institute Proceedings,* January-February.

Personal.—Walter C. Allen, general manager of the Yale & Towne Manufacturing Company, New York, has been elected vice-president and general manager of the company.

New Books for the Marine Engineer's Library

Elementary Mathematics for Marine Engineers. By J. W. M. Sothern, M. I. E. S., and R. M. Sothern, M. I. E. S. Size, 5 by 7½ inches. Pages, 174. Illustrations, 28. Glasgow, 1914: James Munro & Company, Ltd. Price, 2/6 net.

Intended by the authors as an introduction to the study of mathematics, this book has been specially written for the use of marine engineers who may not have had the opportunity of studying this subject during their earlier education. The subject has been treated from a very elementary standpoint, and the book may be likened to a stepping stone between ordinary arithmetic and mathematics proper. The book is divided into four sections, dealing with elementary algebra, logarithms, temperature entropy diagrams and elements of trigonometry. Those men who have been baffled in attempts to master the subject of marine engineering on account of the mathematical calculations involved therein will do well to secure a copy of this book and make a new start.

Newcastle-Upon-Tyne Year Book and Commercial Review, 1914 (with Sunderland section). Edited by Herbert Shaw, B. A., F. R. G. S. Size, 7¼ by 9¾ inches. Pages, 230. Numerous illustrations. Newcastle-Upon-Tyne, 1914: The Newcastle and Gateshead, Inc., Chamber of Commerce. Price, 2/6.

This is the second issue of a year-book compiled to provide reliable information as to the nature of the extensive industries carried on in the Newcastle and Gateshead district. It includes matter of historical interest regarding the district, and of the doings of the Chamber of Commerce during an existence of nearly one hundred years, and also articles on the business carried on in coal mining and shipping, in iron and steel manufacturing, in shipbuilding and engineering, and in other industries, the chief aim of the book being, of course, to give commercial men in other parts of the world reliable data regarding the resources of this locality and the ability of the manufacturers of all kinds to meet almost any demands made upon them.

Turbines Applied to Marine Propulsion. By Stanley J. Reed, Assoc. M. Inst. C. E. Size, 7¼ by 10½ inches. Pages, 174. Illustrations, 113. New York, 1913: D. Van Nostrand Company. Price, $5 net.

The contents of this volume consists of a special course of lectures given by the author at the Naval Architecture Department of Glasgow University, although in some places the lectures have been amplified. The book is more especially intended for practical use, and for this reason thermodynamics and mathematics are entered into as little as possible. The book is of particular value on account of the thorough and complete descriptions given of the design and construction of the Parsons, Curtis, Zoelly, Rateau, Tosi, Melms-Pfenninger and other types of turbines. The size of the book enables the use of large and clear diagrams and illustrations, many of them being presented in the form of folding plates, so that the details of construction can be shown complete. The titles of some of the chapters given below indicate the wide scope of the book and its usefulness in covering such subjects as have to do with the successful application of turbines to ship propulsion. For instance, there are chapters on the steam thrust of reaction and impulse turbines; balancing propeller thrust; superheated steam, with descriptions of various types of superheaters; cavitation, showing the limitations of the speed of propellers and the various types of reduction gear that can be interposed between the propeller and the prime mover; the relative effect of high vacua with turbines and reciprocating engines; the utilization of auxiliary engine exhaust in the turbines, and the utilization of the auxiliary engine exhaust in feed heaters with the relative advantages of the two systems.

McAndrew's Floating School. By Capt. C. A. McAllister. Size, 6 by 8½ inches. Pages, 250. Illustrations, 37. New York, 1914: Aldrich Publishing Company. Price, $2.

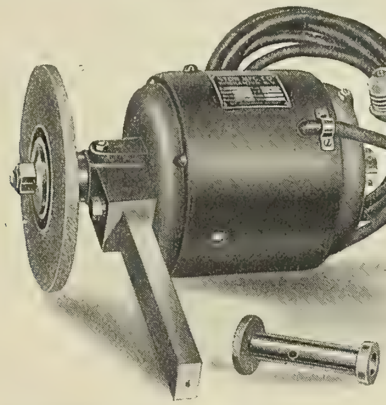
Unlike most textbooks, "McAndrew's Floating School" is written as a story. Four ambitious young men who have begun a seafaring life "below the grating" on an Atlantic steamship, decide to work their way up from positions as oilers, coal passers, water tenders and firemen to the coveted post of licensed engineers. They prevail upon their chief engineer to help them out by giving them instruction in the elements of marine engineering. The instruction is given in the form of lectures, in simple everyday language which men in the engine room of a steamship can readily understand. The lectures cover a wide variety of subjects, beginning with explanations of force, work and power, heat, combustion and the generation of steam. The various materials used in marine engineering are taken up so that the young men can fully comprehend the limitations and usefulness of such materials. Starting at the source of power—that is, with the boilers—a very exhaustive description is given of the construction of steam boilers and of their fittings and accessories. Going then to the engine room, everything which goes into the make-up of the complex machinery of a steamship is described in detail, including all the auxiliaries, pipes and valves and electrical apparatus. A lecture is devoted to the subject of indicators and horsepower, and then the ambitious students are instructed in the care and management of boilers, engines and auxiliaries, giving them a chance to apply under actual working conditions the knowledge which they have gained from the earlier lectures. The final chapter contains a large number of questions and answers.

Every young man who is seeking promotion in the engine room on board ship should read this story and study the lectures given to the students in McAndrew's Floating School." The author of the book, Capt. C. A. McAllister, Engineer-in-Chief of the United States Revenue Cutter Service, is a well-known writer on marine engineering subjects, and in this book he has entered into the spirit of the story as can be done only by a man whose personal experience has brought him into intimate contact with every detail of the subject of which he is writing. As stated by the author in the preface: "The men 'below the grating' of a steamship are the backbone of modern seafarers, as they bear the heat and burden of the work of transportation. Inured from early youth to the hardest physical toil known to man, it is scarcely to be presumed that their early education is such as to fit them for the higher positions in engineering." It is to help men of this type that the book has been written, and the author pays further tribute to his readers by saying: "Certainly these men, the oilers, coal passers and water tenders and firemen of the world's merchant marine are deserving of the efforts of all who can be of assistance to them. The transformation from sail to steam on the great oceans of the world has been so rapid that poets and writers generally are still singing the praises in song and story of the old-time mariner, and have not awakened to the fact that the sailor has been replaced by the man in the fire-room or engine-room. Some of the romance of the sea has disappeared with the sailorman, but heroism is as much and more in evidence with his begrimed successor. Where in the annals of seafarers was ever shown greater heroism than that displayed by the engineers' force of the ill-fated *Titanic*, who almost to the man sank with their ship and at their posts of duty? All the world knows that these hundreds of brawny artisans of the deep could have seized the boats and escaped with their lives; but they were men, and it is for the thousands of men like them that this book was written."

ENGINEERING SPECIALTIES

Electric Tool Post Grinder

For grinding centers, dies, cutters, etc., and also for both internal and surface grinding, the Stow Manufacturing Company, Binghamton, N. Y., supplies an electric tool post grinder fitted with a 3/8-inch by 6-inch emery wheel and an internal



grinding attachment. The tool is attached by a flexible cord to any standard lamp socket and can be furnished to operate on 110 or 220 volt 60 cycles alternating current or 110 or 220 volts direct current.

The Use of the Non-Return Valve in Preventing Accidents

The most important uses of the non-return valve are to equalize the pressure between the different units in a battery of boilers, and to prevent the flow of steam from traveling in a reverse direction to its normal flow.

In case a tube blows out in a boiler, the non-return valve closes automatically, owing to a reduction of pressure, and prevents the header steam from entering the boiler. It acts also as a safety stop to prevent steam being turned into a cold boiler when men are working inside, because it cannot be opened when there is pressure on the header side only.

To be successful, a non-return valve should not open until the pressure in the boiler is equal to that in the header. It should not stick and become inoperative; it should not hammer or chatter while performing its work, and it should be so designed that wire-drawing will not cause wear on the seat and the resulting leak.

In adopting these fundamental principles of safety necessary for the operation of a non-return valve, the Nelson Valve Co., Philadelphia, Pa., have added many additional operating and construction details to the Nelson Cushioned Non-Return Stop Valve, which are interesting from an engineering standpoint, and necessary for reliable operation.

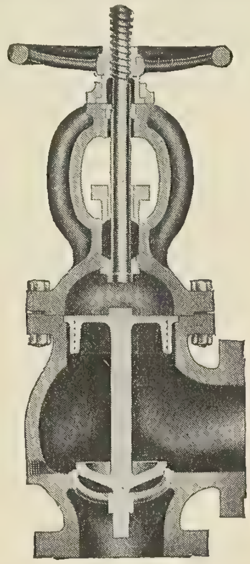
The valve is so constructed that it operates automatically, like an ordinary check valve, and it can be used as a stop valve. It contains an internal dash-pot, having the full area of the valve opening, which acts to cushion the effect of opening and closing the valve. The dash-pot is always at the same temperature as the other working parts, so that contraction or expansion of all parts will be equal, and there can be no binding of the piston; it is, therefore in condition to operate uniformly under all conditions. It is made separate from the body and bonnet castings, thus allowing perfect alinement with the piston.

The piston is made the same depth as the dash-pot, so that in traveling up and down in normal operation there can be no shoulder formed, thereby the cause of sticking, which is fatal to a valve of this type, is removed.

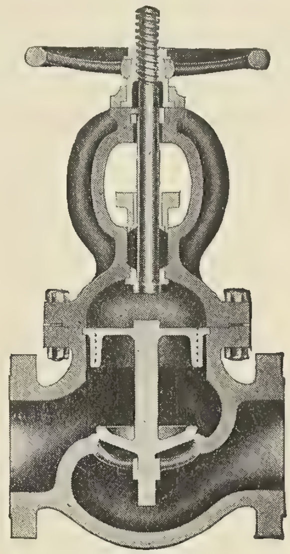
The piston and disk are made in one solid piece of bronze. The disk is provided with a lip below the finished seating surface, which is designed to give an easy flow of steam.

Since a valve of this type must necessarily operate continuously with a short-stroke the damage from wire drawing is considerable, and naturally, with incorrect design, this wear will cause serious leakage. In the Nelson Cushion Non-Return Valve, the lip located below the seating surface absorbs this wear; the seating surface remaining in a smooth condition.

When it is desired to use the valve as a non-return valve, the hand-wheel is opened, as with an ordinary stop valve.



Angle Cushioned Non-Return Valve



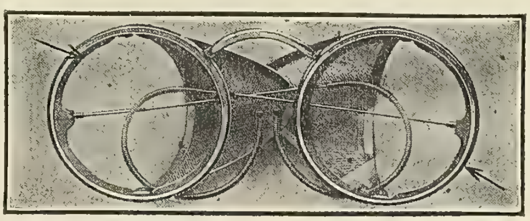
Straightway Cushioned Non-Return Valve

This allows the disk, which is a part of the piston, to operate automatically in the dash-pot with slight changes of pressure. When it is desired to use it as a stop valve, the hand-wheel is screwed down in the usual manner. The hand-wheel is made stationary, so that the valve may be operated with small head room, which feature is often of great importance in many boiler plants.

In the installation of these valves of either the angle or globe pattern, they should be so placed that the pressure is always under the disk, with the stem vertical. They can then be packed when open and under pressure.

Improved Eye Protector for Industrial Workers

Safety goggles, which are claimed to embody new principles in industrial eye protection, have been brought out by T. A. Willson & Company, Inc., Reading, Pa. Instead of the saddle resting upon the bridge of the nose there is an adjustable brace bridge designed to distribute the weight evenly upon the sides of the nose and the cheeks.



A safety flange, which is part of the rim, extends over the back edge of the glass to give resistance to blows struck on the lens and holding the glass securely, thus, it is pointed out, preventing injury to the eye from splinters. The wire side screens are either detachable or else are fastened so that they cannot be removed. The shape of the screens is rather unusual, being long and narrow, which, it is emphasized, gives protection without the irritation caused by the edges rubbing and pressing into the cheek and forehead.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

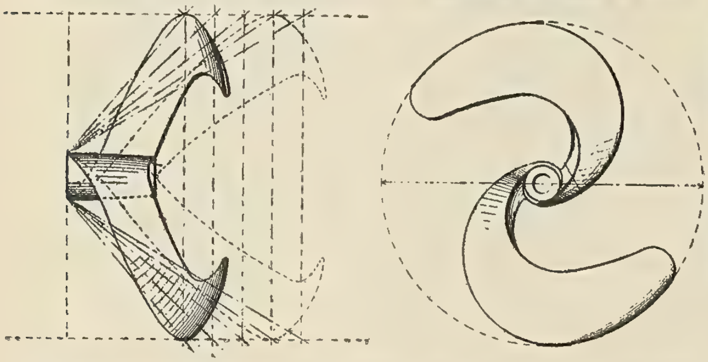
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,080,625. INTERNAL COMBUSTION PROPULSION APPARATUS. RUDOLPH DIESEL, OF MUNICH, GERMANY, ASSIGNOR TO BUSCH-SULZER BROS.-DIESEL ENGINE COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

Claim 1.—An internal combustion engine plant comprising two divisions, an air compressor arranged for operation by one division and propelling mechanism adapted for operation by the other division, in combination with suitable means for driving the latter division by means of the air from the compressor, and means for combining both divisions to operate the said propelling mechanism. Seven claims.

1,087,203. PROPELLER. JULIUS WILLIAM WALTERS, OF GLENS FALLS, N. Y.

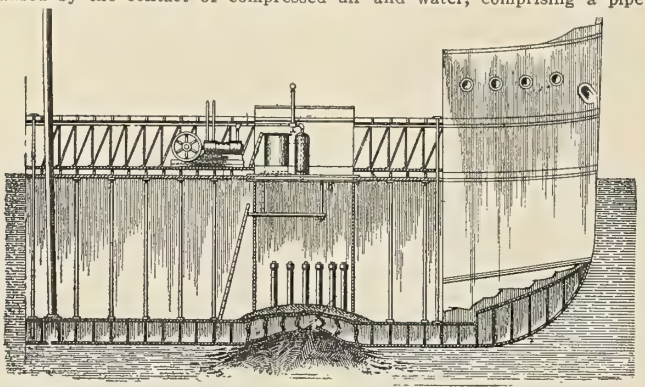
Claim.—A propeller comprising a hub and blades extending outwardly and rearwardly from the hub along a conical spiral curve through approximately 180 degrees to a predetermined maximum diameter, and thence along a helical cylindrical curve of said maximum diameter less than 45 degrees, whereby to prevent overlapping in end projection of the blades, said blades increasing in width from the hub to the point of maximum diameter, thence decreasing in width to their



ends and decreasing in thickness towards their ends, the working faces of the blades commencing tangent to the hub, whereby to admit of free radial flow of the fluid from the hub and offset vortexing, said working faces continuing outwardly and backwardly at an increasing inclination to the transverse plane of the hub, the rear edges of the blades lagging behind the cutting edges up to the point of maximum diameter, and thence being uniformly inclined, whereby the propeller is given worm action effecting the movement of the fluid in a substantially solid column, the outer cylindrical portions of said blades acting upon the solid column of the fluid. One claim.

1,089,967. METHOD AND APPARATUS FOR FLOATING AND REPAIRING STRANDED VESSELS. HERBERT B. SAUNDERS, OF NEW YORK, N. Y.

Claim 3.—A device for confining to a restricted area pulsations caused by the contact of compressed air and water, comprising a pipe



having a flanged base provided with a plurality of apertures, spacing elements arranged in said apertures for holding said base spaced from its support, and an apron disposed between said base and the support on which said base rests. Five claims.

1,081,843. INDICATOR. LAWRENCE S. LARSON, OF TOLEDO, OHIO.

Claim 1.—In a ship's ballast indicator, the combination with a ballast tank, of a float vertically movable therein, an electrical circuit including a volt meter, a bank of resistance elements serially connected to one terminal of the circuit, a contact member rigidly connected to and actuated by the float, a flexible connection between the opposite terminal of the circuit and the contact members and means to insure engagement of the contact member with one resistance element at all times. Two claims.

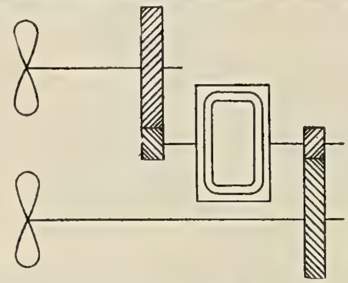
1,081,679. ATTACHMENT FOR LIFE-BOATS. CHARLES H. LANGILL, OF BOSTON, MASSACHUSETTS.

Claim 1.—In a device, the combination of a supporting member including an eye; a telescopic supporting member; a downwardly extending hook pivoted thereto adapted to engage said eye, said hook having its pivotal axis in the same plane with said hook; and a weight adapted to turn said hook about its pivotal axis to release said eye. Eight claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finbury, E. C., and 10 Gray's Inn Place, W. C., London.

18,977/1913. SYSTEMS OF MARINE PROPULSION AND APPARATUS THEREFOR. W. J. ROSS, 52 BARNS STREET, CLYDEBANK, GLASGOW.

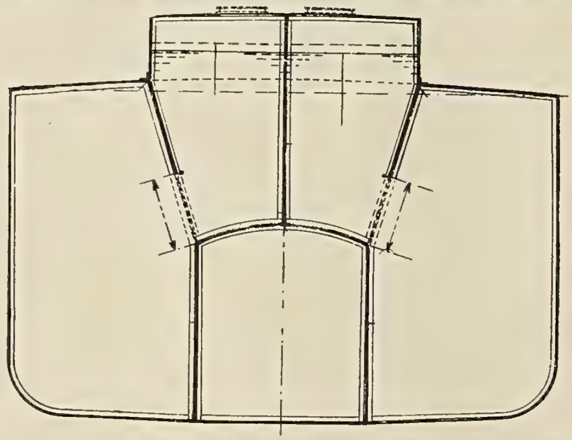
Claim.—This invention relates to the application of radial-flow turbines, of the type having oppositely rotating members within the same casing, to the propulsion of marine vessels, and comprises installations having two or four shafts, two shafts being driven by one turbine of



the radial-flow type having oppositely rotating members, each of which drives one shaft; or in installations having one or more shafts, driving the shafts independently by a radial-flow turbine having oppositely rotating members, one of which is geared direct to the shaft, and the other geared to the same but driving through an intermediate wheel. Either of these arrangements may be used as a cruising turbine, as an independent turbine or in series with the main turbines.

24,741/1912. IMPROVEMENTS IN OR RELATING TO TANK SHIPS OR VESSELS. D. BLACK, of 88 PARK ROAD, NEWCASTLE-ON-TYNE.

This invention relates to the construction of tank ships, for the transportation of liquids or semi-liquids in bulk. A central tank is provided for the storage of water ballast when oil is not being carried, and is equipped with an expansion trunk. Adjoining this chamber are side



tanks also equipped with expansion trunks. The extended sides of the deck trunk are formed with air holes to lighten the structure, while wash plates are provided in the expansion trunk of the central oil hold, and longitudinal oiltight bulkheads are arranged, respectively, between the side oil holds, and in the lower part of the oil holds.

19,780/1912. IMPROVEMENTS IN AND RELATING TO SYSTEMS OF SHIP PROPULSION. THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED, 83 CANNON STREET, LONDON, E. C.

This invention resides in a method, in a system of ship propulsion in which a plurality of propeller shafts are employed having turbines or turbine stages, mounted on each, of operating at slow or cruising speeds, which method consists in supplying steam only to turbines on some of the shafts, the other shaft or shafts remaining idle, and in allowing the steam to expand to practically the same extent or in the same number of stages as when working at high speed. The intermediate stages or pressure turbines on the idle shafts are by-passed and the steam caused to pass directly from the higher stage to a lower stage on one of the operating shafts.

20,095/1912. IMPROVEMENTS IN CHANGE SPEED GEARING, SPECIALLY ADAPTED FOR SCREW PROPELLERS AND OTHER MECHANICAL DEVICES WHERE END THRUST EXISTS. J. MONAGHAN, 17 ORME STREET, BLACKPOOL, AND OTHERS.

This relates to a change speed driving mechanism (for screw propellers and other mechanical devices where end thrust exists) of the type in which the first motion and driven shafts are placed in line with the end of one abutting against the end of the other, and in which these two shafts are geared together near the place where they abut by a counter shaft and differential gear. By this invention the differential gear wheels are attached to their respective shafts, and the counter shaft can be raised to bring its gear wheels out of mesh with those of the driving and driven shafts. Means are provided for coupling the driving and driven shafts together when the counter shaft is raised out of gear, or uncoupling them when the counter shaft is lowered into gear, substantially as described.

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Difficult Dredging Operations at Bermuda

Two Powerful Bucket Dredgers with a Specially Constructed Drill Scow Make Rapid Progress in Opening Up the Town Cut Channel at St. Georges

Next to the tourist business, Bermuda's greatest prospects are undoubtedly in connection with the bunkering of steamships, and in administering "first aid to the injured" to distressed shipping. Owing to the lack of channel accommodation at St. Georges, this business has been almost exclusively carried out at Murray's anchorage, an open roadstead with no accommodation. Realizing that unless steps were taken to provide safe and economical harbor accommodation at St. Georges this most important trade would be deflected to other ports, the Government of Bermuda had the dredger *King George* built specifically to dredge the Town Cut channel at St. Georges.

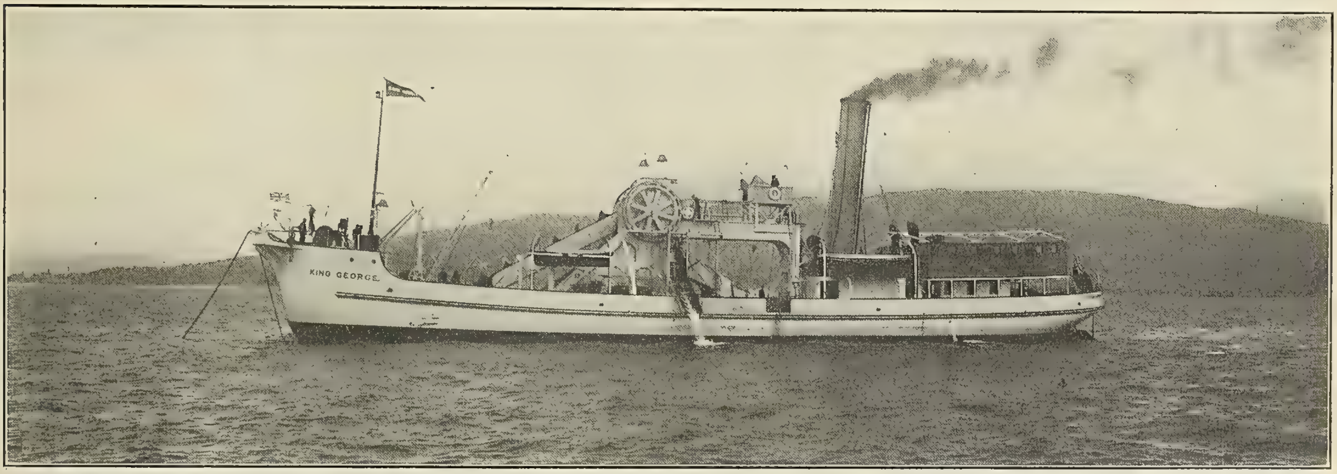


Fig. 1.—Twin-Screw Bucket Dredger *King George* in Operation at Bermuda

The conditions are extremely severe, as the majority of the material to be dredged is a very tough conglomerate, presumably originally the ocean bed, which had been forced by some peculiar convulsion of nature to the surface, and there forming the nucleus for the group of the Bermuda Islands. This rock, in combination with an almost ever-present ocean swell at the outer portion of the channel, has presented conditions bristling with difficulties.

The *King George,* which is a bow well, twin screw, bucket and ladder hopper dredge, built by Messrs. Lobnitz & Company, of Renfrew, has successfully coped with this work. The buckets, 32 in number, are of cast steel body, with manganese steel cutting lips, and travel at the rate of about 16 per minute. A few minutes' experience on the *King George* while at work will convince the most skeptical that any other material of a lesser degree of hardness than manganese steel would be utterly valueless in dredging this Bermuda lime stone. The hoppers, when full, hold 400 tons, and this load is generally augmented by from 15 to 20 tons of boulders, which have to be taken out of the buckets and placed on deck to prevent wrecking the shoots.

Blasting, which has to be resorted to constantly, is carried out from the drill scow *Suffragette.* Previous to the building of this drill scow, the drilling was carried out from the dredger. Two Ingersoll-Rand H.9 drills were mounted, one on each bow, and the dredger was moored for drilling by lowering the ladder to the bottom, acting as spuds. This necessitated the complete discontinuance of dredging operations while drilling; and as about four days' drilling was necessary to prepare for two days' dredging, this gave an output of about 900 tons of hard rock per week. It can readily be seen that the dredger, while economical for its legitimate work, was a most expensive tool when used for a drill scow. The output of rock, since the building of the drill scow, has been raised from 900 to over 4,000 tons per week. It is interesting to note that this material is being dredged for about 50 cents (2/1) per cubic yard.

When open the Town Cut channel will be 120 feet wide at the bottom, and 24 feet deep at low water, giving a perfectly straight channel from the sea to the commodious harbor of St. Georges. By means of range lights placed ashore, it will be comparatively easy for vessels to enter port at any hour at night as well as in daylight, in about 15 minutes from the sea.

Owing to the rapidly increasing tourist trade to Hamilton, it became obvious that these channels would have to be opened

to meet the demand of the large ships engaged for this trade, before the *King George* could complete the St. Georges channel, and so a second dredger was ordered from the builders of the *King George*. This dredger, the *Queen Mary*, arrived at Bermuda after a particularly hard passage, in January last, and is a duplicate of the *King George*.

Both dredges were built by Messrs. Lobnitz & Company, Ltd., Renfrew, to designs of Messrs. Coode, Matthews, Fitzmaurice and Wilson, London. They are 170 feet long, 34 feet beam, and 13 feet 3 inches depth. Propulsion is by twin screws driven by triple-expansion, three-crank engines of a collective indicated horsepower of 1,200. Each of the propelling engines can be coupled to the dredging gear. The dredging buckets are of 9 cubic feet capacity each, and the gearing throughout is of steel, teeth being machine-cut from the solid. The top tumbler wheels are fitted with lubricated side friction of the usual Lobnitz pattern, which can be adjusted to slip at the desired horsepower. The auxiliaries include an electric lighting plant, Weirs pumps, an evaporater, filter, feed-water heater, and steam steering gear, besides the usual deck auxiliaries. Accommodations for the officers are arranged in deckhouses on the upper deck, the woodwork throughout being of teak.

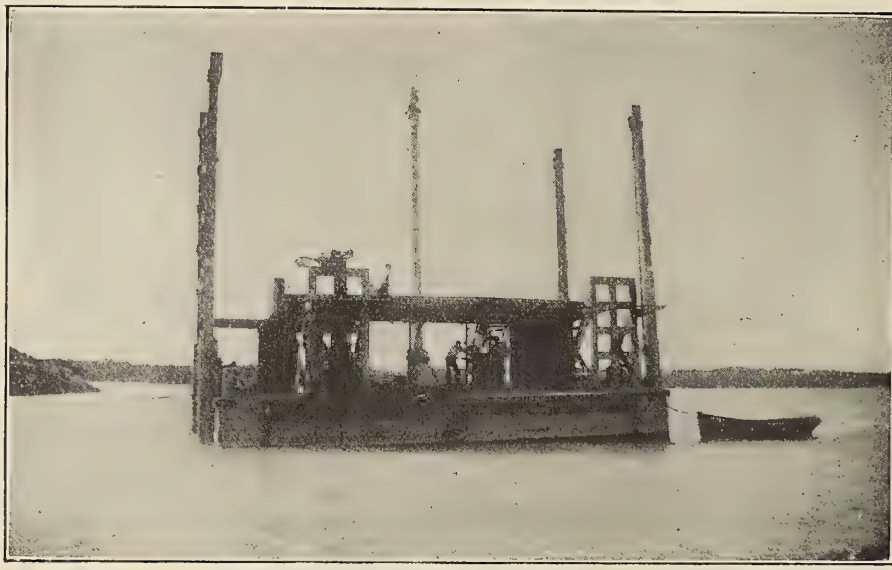


Fig. 2.—Drill Scow *Suffragette*

The *Queen Mary* is employed improving the Staggs channel, near the government dockyard. The fact that a small colony like Bermuda, with a population of 20,000 people, has purchased and paid for two dredgers, costing about $350,000 (£71,800), and are spending about $80,000 (£16,400) per annum in channel improvement, is good evidence that they not only expect a healthy increase in their tourist business, but that they intend to be prepared for an increased volume of business when the Panama Canal is open.

Fig. 3.—Ingersoll-Rand Drill in Operation on the *Suffragette*

Fig. 4.—Explosion in Town Cut Channel

The drill scow *Suffragette* was designed and built by Mr. W. B. Smith, engineer in charge of channel and harbor improvement works, at Bermuda, to meet specifically the requirements of local conditions. The draft was limited to 18 inches, and a limit of 40 feet was decided upon for the length. The breadth is 25 feet and the depth is 5 feet.

The scow is built of pitch pine and spruce. The planking and deck is 2½ inches by 12 inches, and the framing 4 inches by 8 inches. To protect the hull from worming the bottom is covered with three coats of tar and arsenic. The cost of the scow, without drills, amounted to about $4,150 (£850).

A feature of the scow is that all exhausts are led to a keel condenser composed of about 160 feet of 2-inch galvanized pipe bolted under the bottom, and connected to a Davidson air pump, 4 inches by 6 inches by 8 inches. Although the scow is practically stationary, and the temperature of the sea water in summer is about 75 degrees F. at the surface, nevertheless a vacuum of 22 inches is easily held. The two H.9 Ingersoll-Rand drills work exceedingly well exhausting to vacuum, and the absence of exhaust steam around the work is particularly beneficial. Owing to scarcity of fresh water in Bermuda in summer, the saving of water is also a most important feature.

The scow is moved from place to place by a kedge and warp from the nigger head of the steam winch, and moorings are handled from the same, while the drum of the winch is used for hoisting boulders. There are four pitch pine spuds, 9 inches by 9 inches each, 34 feet long, and steel shod. These are also hoisted from the nigger head of the winch, and are held down by a wire down-haul pennant and fall, secured to an eyebolt on the deck.

The drills are mounted on drill frames, as shown in Fig. 3, movable fore and aft on a steel-faced track. A corrugated iron roof extends over the drill track, and steam and exhaust pipes are secured to this. Connections to the drill cylinder and feed engine are made by flexible steam hose. The powder house is located on deck at the opposite corner from the boiler house.

The longest drill used is 35 feet and shortest 10 feet. About 4 pounds of blasting gelatine are used per hole. The scow has been used in the outer portion of the channel in a moderate ocean swell, and has given very fair results, even under these extreme conditions. Owing to the fact that there is no regularity to the hard rock, it is found that the cheapest and most satisfactory method is to locate pumps and charge holes with a diver.

The boiler is of the vertical tubular type, 4 feet diameter by 6 feet 6 inches high, with 140 2-inch tubes, 3 feet 4 inches long. The steam pressure is 60 pounds gage. This boiler easily supplies steam for two drills, the air pump, a duplex pump for forcing water in the holes while drilling, and for the steam winch.

The appointment of Mr. W. B. Smith as engineer in charge of channel and harbor improvement works was made provisionally in May, 1913. At that time the output of material from the dredging operations averaged only 970 tons per week. By the following September, however, when Mr. Smith's appointment was made permanent, the weekly output had been increased to 4,500 tons. These results were attained, first, by the constant supervision of the works by the engineer in charge; second, by the addition to the equipment of the drill scow described above; and third, by encouraging harmony among the employees.

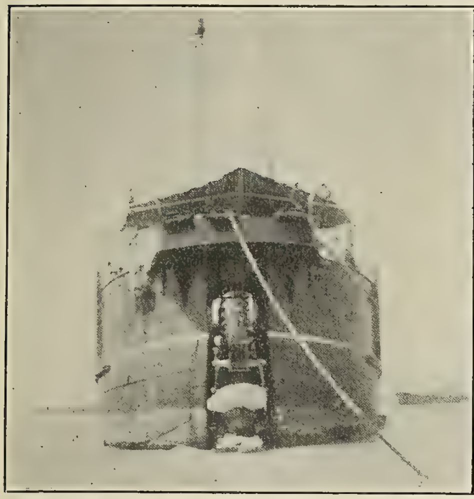
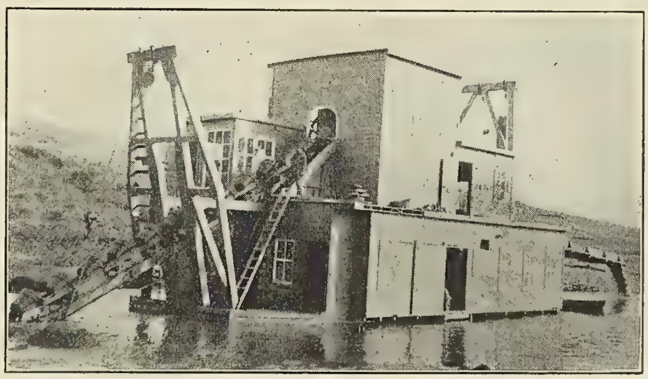


Fig. 5.—Bucket Dredger Raising Large Boulders

Fig. 6.—Boulders Taken from the Buckets of the *King George*

Gasoline (Petrol) Motor Bucket Dredge

The illustration shows a 2-cubic foot bucket dredge, driven by gasoline (petrol) motive power, built by the American Dredge Building & Construction Company, Seattle, Wash., which has been operated by the Deering Dredging & Mining Company for the past two seasons on the Inmachuk River, Alaska. The dredge has worked in broken lime bed-rock, and has handled an average of 1,000 cubic yards of material per day of twenty-four hours. The dredge is of the flume type, designed to allow the installation of a screen and stacker, if so desired, and to dig 15 feet below the water level. The hull is 54 feet long, 26 feet beam and 4 feet deep. The bucket line is of the open-link type, and the buckets are made with hoods and bottoms cast in one piece of steel, with manganese side links, connecting links, bucket lips, pins and bushings. The dredge is equipped with gasoline (petrol) motive power, and centrifugal pumps are used to pump water from the pond in which the dredge is floating for washing the gravel. The flume is lined with riffles and a special design of fine gold-saving device. Several new innovations have been introduced on this dredge, adapting it particularly for recovering gold values contained in shallow creek beds. The dredge is very inexpensive and has a total shipping weight of only 100 tons. All parts are designed to permit transporation to far inland points.



2-Cubic Foot Motor Gold Dredge

A Simons Suction Hopper Dredger Fitted with Special Sand Trapping Apparatus

Figs. 1 and 2 show views of the 3,000-ton suction hopper dredger *Balari* constructed last year by Messrs. William Simons & Company, Renfrew, to the order of the Calcutta Port Commissioners. Owing to the great volume of drift sand and silt of very light specific gravity deposited in the Hooghly during the flood season special consideration was given to appliances which would efficiently retain this light material, and prevent a large percentage of loss in the overflow from the hopper when dredging operations were in progress. The dredger was accordingly fitted with "Simons" patent sand trapping arrangement.

Fig. 1.—3,000-Ton Hopper Dredger *Balari*

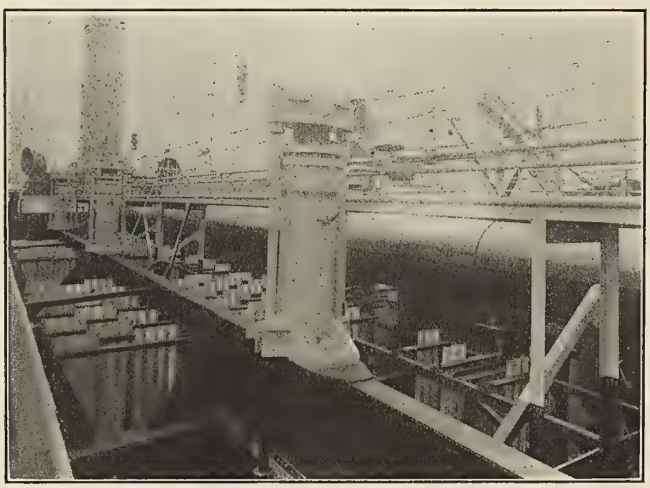


Fig. 2.—Sand Trapping Apparatus on the *Balari*

On the official trials on the Hooghly River the *Balari* filled her hopper in the remarkably short time of 19 minutes. This result was, to a very considerable extent, due to the efficiency of these sand baffling arrangements. As the loss in overflow is frequently considerable, and becomes excessive in certain classes of material when the hopper gets more than half full, it is evident that an apparatus which reduces the loss in overflow from the hopper as much as possible must materially affect the efficiency of the dredge and at the same time reduce the actual cost of dredging.

The *Balari*, which is 333 feet in length by 54 feet 6 inches beam by 22 feet 3 inches depth, has a hopper capacity of 71,600 cubic feet. The hull and machinery are constructed to Lloyd's highest class. The main deck is of steel sheathed with teak. Steam and hand steering gear is fitted, and a very complete installation of electric lighting is provided, including two searchlights.

The propelling and pumping engines are placed in two independent compartments. The propelling power is supplied by two sets of triple-expansion, surface-condensing engines, embodying all the latest improvements in marine engine practice, including steam and hydraulic reversing gear, steam turning gear, independent circulating pumps, automatic feed pumps, feed heaters and filters, large evaporators for feedwater make-up, and a complete outfit of auxiliary feed and bilge pumps. Steam is generated by four large single-ended horizontal multi-tubular boilers, constructed to Lloyd's rules for a working pressure of 180 pounds. These boilers are designed with ample surface for burning Bengal coal under forced draft. An ash ejector is fitted in the stokehold. The pumping outfit, placed forward of the hopper in an independent engine room, consists of one set of triple-expansion engines, with independent condensing plant and circulating pumps, complete with all modern fittings. The pump engines are coupled direct to a centrifugal sand pump specially designed to raise and discharge about 5,000 tons of sand and silt per hour. The pump is connected to a suction pipe placed in a well at bow of the vessel. At the upper end the pipe is fitted with a massive swivel bend, which serves as a trunnion or hinge upon which the pipe is free to move vertically. The suction end of the pipe is fitted with a specially-designed nozzle to suit the character of the material to be dredged, while a grid is also fitted to the nozzle to exclude material which might choke or damage the pump. The suction pipe is controlled by a steam winch placed on deck.

The discharge pipe from the sand pump is carried aft of the hopper.

One of the outstanding features of the deck equipment of this dredger is the extensive and powerful installation of mooring winches to regulate the movements in the rapid currents of the River Hooghly.

The bow winch has four large independent wire-rope drums for working long lengths of heavy steel wire rope. The winch is driven by a vertical high-pressure engine, the gearing throughout being of steel. In addition, at the bow, a very massive windlass is fitted having four independent cable holders and two warping ends. At the stern a large windlass is fitted having two independent cable holders and two warping ends of extra large dimensions.

A large workshop is fitted below the deck so that all gen-

eral repairs may be effected on board. The outfit of machine tools is very complete, and consists of lathes, shaping machine, radial drill, etc., and also a smith's forge, with mechanical fan, all driven by electric motors.

15-Inch Hydraulic Dredge for Barge Canal Work

During the last year the Morris Machine Works, Baldwinsville, N. Y., built for Grant Smith & Company & Locher, Rome, N. Y., for use on the New York Barge Canal, a 15-inch hydraulic dredge, the general arrangement of which is shown herewith.

The hull is of wood 100 feet long by 33 feet wide by 8 feet depth, with a load draft of 4 feet 6 inches. It is of very heavy construction, and is further stiffened by two heavy steel trusses and two hogging trusses running the full length of the hull.

The machinery equipment consists of two 300-horsepower Erie watertube boilers, carrying 150 pounds steam pressure, and one cross-compound vertical engine, with cylinders 15 and 28 inches in diameter by 18 inches stroke, driving a 15-inch suction and discharge dredging pump. The shell of this pump is made of manganese steel, and the side disks of carbon steel with manganese steel lining. The pump and engine are mounted on a heavy base, which also carries a multi-collar thrust bearing of the marine type.

The winding machinery consists of a 7¼-inch by 10-inch horizontal double engine driving five drums through cast steel gearing, the ratio of gearing being 22.6 to 1. The drums are 18 inches in diameter and 18 inches long. The cutter is driven by a 10-inch by 10-inch double horizontal engine through three pairs of cast steel gearing of extra heavy proportions, the ratio of gearing being 18.6 to 1.

The auxiliaries include a double-flow surface condenser, containing 800 square feet of cooling surface; a horizontal simplex air pump, 8 inches by 14 inches by 12 inches; a 6-inch centrifugal circulating pump, directly connected to a 5-inch by 5-inch vertical engine; two duplex feed pumps, 6 inches by 4 inches by 6 inches; one duplex fresh-water pump, 5¼ inches by 4¾ inches by 5 inches, and two duplex general service

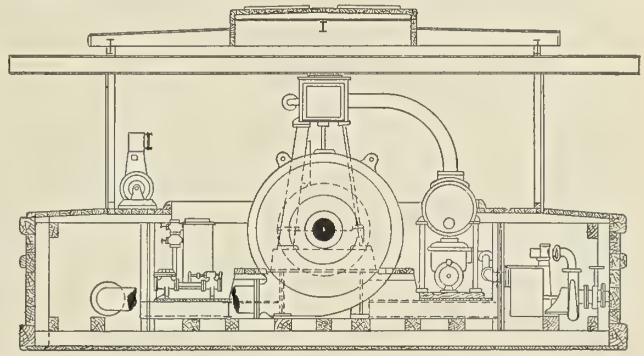


Fig. 2.—Midship Section

pumps, each 5¼ inches by 4¾ inches by 5 inches. One vertical marine type multi-coil feed-water heater, capable of taking care of 13,500 pounds of water per hour, is provided, together with a steel hot well of 270 gallons capacity, and one 6-kilowatt, 110-volt generator, direct connected to a 6-inch by 5-inch vertical engine.

The ladder is of structural steel, 57 feet long and 10 feet wide over the trunnions, with side girders of 7/16-inch plate 30 inches deep. The cutter is of the built-up type, with six blades of special steel, actuated by a shaft 6 inches in diameter enlarged to 7 inches through the suction head.

The suction pipe is of lap-welded construction, 15 inches inside diameter, with the flanges welded on. The suction pipe enters the hull at the upper end of the ladder through steel swivel trunnions of the Morris type, provided with both

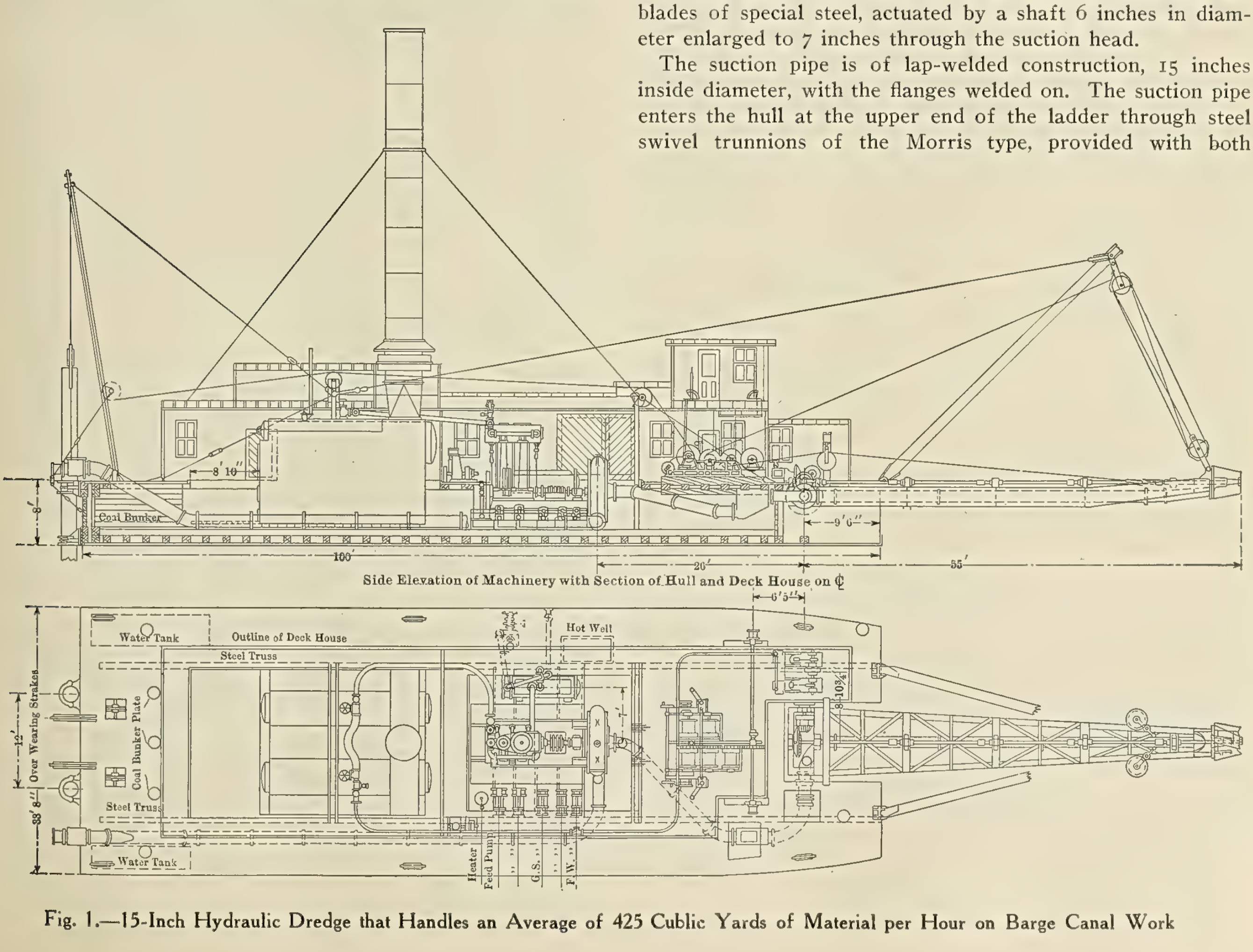


Fig. 1.—15-Inch Hydraulic Dredge that Handles an Average of 425 Cublic Yards of Material per Hour on Barge Canal Work

packing gland and water seal to insure absolute air tightness under all conditions. The trunnion joint is entirely above water, accessible at all times, and so designed that all parts subject to wear can be easily and quickly renewed.

The elbows connecting with the suction pipe are of cast steel of extra long radius. The angle at which the ladder can dig is not limited as with a ball joint. The outer end of the ladder my be lifted high out of the water and placed on banks or on a high side scow, or in case of breakage of a wire in the ladder fall, with the dredge in deep water, the ladder may swing down and back under the dredge without doing any harm. With the ball-joint construction the range is limited both up and down, and in case of breakage very serious damage may result.

The spuds are of wood 23 inches in diameter, having 5,000-pound points on the lower ends. The spud frame is built up of structural steel, and, as is the case with the ladder "A" frame, another frame projecting above the deck-house roof is hinged at the bottom, so that in case of necessity they can all be laid flat to permit passing under bridges.

The spud keepers are of cast steel, and are fastened to the stern of the dredge. They are made in halves, so that by simply removing a pin the gate can be swung open and the spuds removed without the necessity of lifting them up to clear the top keeper, as is the case with spud keepers built in the hull.

All wires for raising spuds and ladders are kept up overhead, where they can at all times be inspected or lubricated and at the same time be properly guarded.

This dredge is working on contract No. 46 of the New York State Barge Canal, and began operation July 1, 1913, working in two 8-hour shifts, or a total of sixteen hours per day. During the first month the dredge was in operation the actual operating time was 365 hours out of a possible 416 hours, or a total of 12 percent lost time for the month. When considering the time lost in changing shore and pontoon lines, swinging cable, cleaning the stone-box, etc., it can be seen that the actual lost time per month, due to any part of the machinery, is a very small percentage indeed. During this time the dredge handled in all 155,000 cubic yards, but as the channel was dug 2 feet below grade the paid yardage was only 145,000 yards. The dredge accordingly handled material at an average rate of 425 cubic yards per hour. The best performance for any 8-hour run was on July 8, when 5,200 yards were excavated, or an average of 650 yards per hour. At the same time the static head remained practically constant, being from 8 to 10 feet. The shortest discharge pipe-line was 1,475 feet, and the longest pipe-line 2,750 feet. The average rate of pumping for six months' operation, with the dredge in operation only sixteen hours per day, is about 102,000 yards per month.

An Electric Suction Dredge for Canal Work

A growing demand for utilizing the advantages of the electric current in operating hydraulic dredges has brought out a number of electrically-driven dredges. Practically all dredge designers agree that the steam-driven dredge offers the greatest "flexibility" in operation, and that the presence of steam under pressure is an advantage for a great many purposes, such as heating, for priming the main dredging pump, etc. Yet the absence of coal, and thereby coal barges, tenders, firemen, etc., tends to lessen the cost of operation where current can be had conveniently and at a moderate price. The comparatively high speed of the electric motors as compared with steam engines necessitates a greater speed reduction, and here is where the efficiency of the design will show up to advantage during continuous operation.

An example of a successful electrically-driven hydraulic dredge is shown in the illustration. This is a 10-inch dredge built for the Fredericksburg Power Company, of Fredericksburg, Va., by the Norbom Engineering Company, of Philadelphia, Pa. The power company owns a comparatively narrow canal, which is over fifty years old and partly filled up with silt. The canal is on the average 40 feet wide and 4 to 6 feet deep. The dredge was procured to clean it out, as well as to deepen it to 12 feet and to widen it to about 75 feet. Strong cutter machinery was needed on account of the hard loam or clay to be encountered, and the pump was designed

Electrically-Driven Hydraulic Dredge

to deliver the material to points sometimes 1,500 feet away against a lift of about 6 to 10 feet.

The main pump is fitted with a 36-inch runner, belt-driven, from a 150-horsepower General Electric motor (25-cycle, three-phase, 2,200-volt, 750 revolutions per minute). Speed variation, as needed to meet the various heads under which the pump must work, is provided by exchanging pulleys of different sizes on the motor. For priming the pump an exhauster working under a water pressure of 50 pounds was provided in a manner similar to the ordinary steam ejector, the pressure water being provided by a plunger pump driven from a 5-horsepower motor; this same motor is also driving a smaller auxiliary pump, which provides a stream of water for the purpose of flushing the stuffing-box on the main pump and the cutter shaft bearings, as well as water-sealing the ball joint on which the suction pipe is hinged. This ball joint is so made that can be packed and water-sealed, and takes up wear automatically.

The speed reduction on the winding machinery and cutter machinery from the 15-horsepower and 30-horsepower motors installed, is direct through a set of worm and worm-wheel running in oil in an enclosed casing, thus insuring noiseless operation. All necessary auxiliaries needed for the convenient operation of this dredge have been provided, and it seems that in consideration of the fact that the first cost of such a dredge is far less than that of a steam dredge, and under average conditions the cost of operating is also less, there should be no real objection to the electric dredge wherever the power can be had. Furthermore, the power is paid for as consumed, while on a steam dredge a large quantity of fuel, whether coal or oil, must be ordered in advance, and often paid for long before it is all consumed.

Powerful Bucket Dredgers Built in Canada

The Largest Bucket Dredgers Ever Built in Canada Delivered to the Government this Year for Operation in the St. Lawrence Ship Channel

The Collingwood Shipbuilding Company, Ltd., Collingwood, Ontario, has completed two powerful bucket dredgers of the central well type for the Canadian Government's Department of Marine and Fisheries. These vessels are the largest of this type ever built in Canada, and are intended to operate in the St. Lawrence Ship Channel. The principal dimensions are as follows:

Length between perpendiculars.....	215 feet
Breadth, molded	37 feet 6 inches
Depth, molded	14 feet

They are built under Lloyd's special survey to take 100-A 1 dredger class and under government inspection. The dredging gear and propelling machinery are of exceptionally heavy design, in order to cope with the hard pan and rock which is encountered in many parts of the St. Lawrence River. The ladder is of very substantial construction, 117 feet long, and arranged to accommodate a chain of 40 buckets, each of 27 cubic feet capacity. The buckets have cast steel backs, heavy boiler plate bodies and manganese steel lips, and each one is provided with four heavy cutting teeth with tool-steel points. The bucket links are forged and the pins and bushings are of manganese steel. The tumblers are of cast steel, the bottom one being six and the top one five-sided. To stand the wear and tear the bottom tumbler shaft is fitted with a hard steel liner and a manganese steel bush in halves. When the ladder is at an angle of 45 degrees the dredge can dig to a depth of 52 feet below the water level.

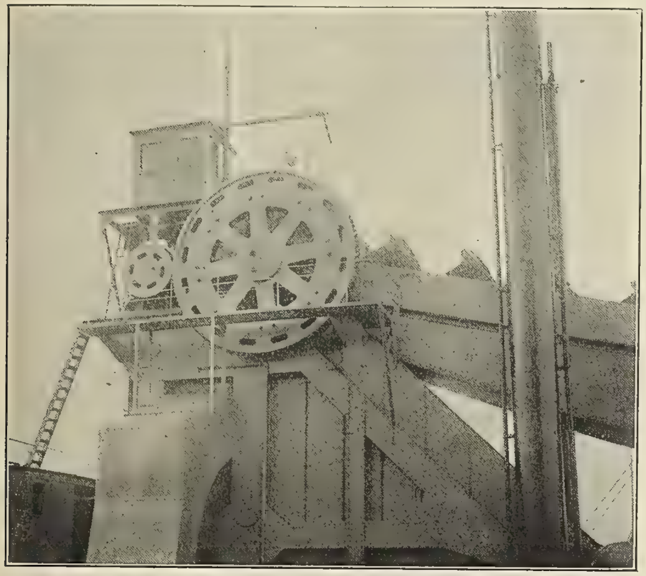


Fig. 1.—Gearing for Operating Buckets

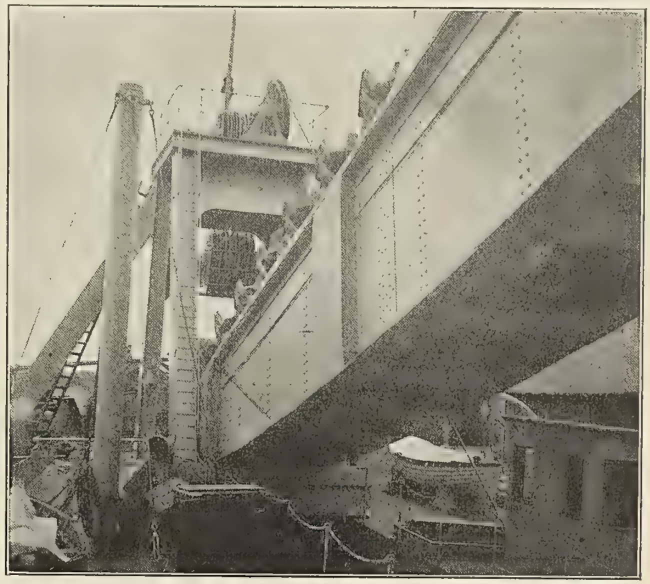


Fig. 2.—Lifting Tackle

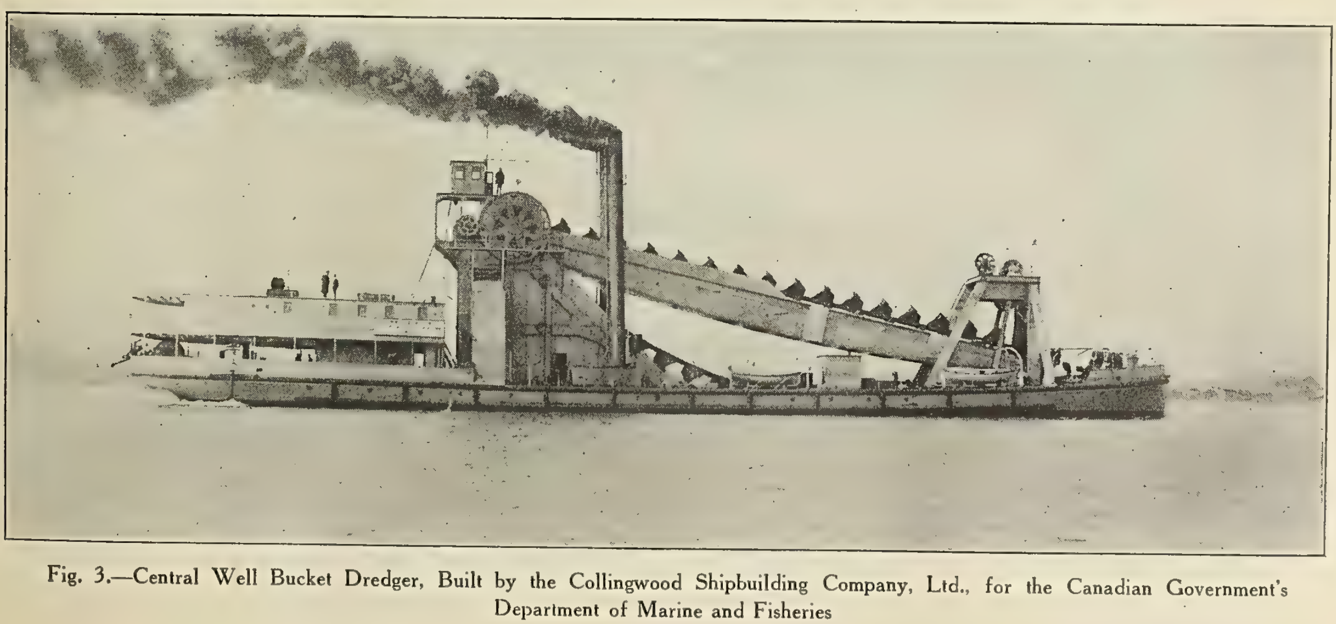


Fig. 3.—Central Well Bucket Dredger, Built by the Collingwood Shipbuilding Company, Ltd., for the Canadian Government's Department of Marine and Fisheries

Propelling Machinery

The propelling machinery consists of one set of triple-expansion, surface-condensing engines of the Collingwood Shipbuilding Company's make, with cylinders 15 inches, 25 inches and 42 inches diameter by 26 inches stroke. A clutch is arranged between the crankshaft and propeller in order to disconnect when the vessel is digging. Forward of the engine a heavy change speed gear arrangement is fitted, having a double clutch so as to give two speeds on the chain of buckets, the low speed being 10 to 12 buckets and the high speed 18 to 20 buckets per minute, the latter speed being intended when dredging in soft material. The vertical shaft driving the top gears and surge wheel is 11 inches diameter, and all the gears and pinions are of cast steel. The surge wheels are each 15 feet 6 inches diameter, the outer rim having double helical teeth. The friction is arranged by means of brass-faced cod pieces and tightening screws.

The boilers are of the usual marine type, two in number, 11 feet 6 inches diameter by 10 feet 6 inches long, fitted with Howden's forced draft, and arranged to work at a pressure of 180 pounds per square inch.

Auxiliaries

A very complete installation of engine room auxiliaries has been fitted, and comprises a 10-inch by 20-inch by 10-inch vertical monotype air pump, one pair of direct-connected feed pumps, 7 inches by 5 inches by 15 inches, one vertical duplex general service pump, 7½ inches by 4¾ inches by 10 inches, one 6-inch centrifugal circulating pump, two vertical simplex bilge pumps, 6 inches by 5 inches by 10 inches, two vertical duplex sanitary and feed-water pumps, 4½ inches by 4 inches by 5 inches, one G. & J. Weir's surface feed heater, one See's ash ejector in each boiler room. A complete electric installation is fitted, consisting of two 11-kilowatt machines, either one of these being capable of handling all the lights aboard the vessel. A 24-inch diameter searchlight of 25,000 candle-power is fitted on the shade deck aft for use in reading draft gages on the river at night. A 60-inch Howden's fan is fitted for supplying the necessary forced draft to the boilers.

The deck auxiliaries consist of one 9-inch by 18-inch bow winch, situated on a flat under the main deck with special lead for chains through a hatch on the upper deck. The drum of the winch is designed to accommodate 4,000 feet of 1½-inch steel wire rope and 300 feet of 1½-inch chain. There are also one 9 inch by 16-inch stern winch and two 9-inch by 16-inch breasting winches, the latter having drums arranged to handle the port and starboard wires. Each winch is capable of accommodating 4,000 feet of 1¼-inch wire rope and 300 feet of 1¼-inch chain cable. Six anchors are fitted for working the vessel—one bow, one stern and four breasting. These are of the ordinary type with stocks, and are of suitable weights for securely mooring the dredge when working.

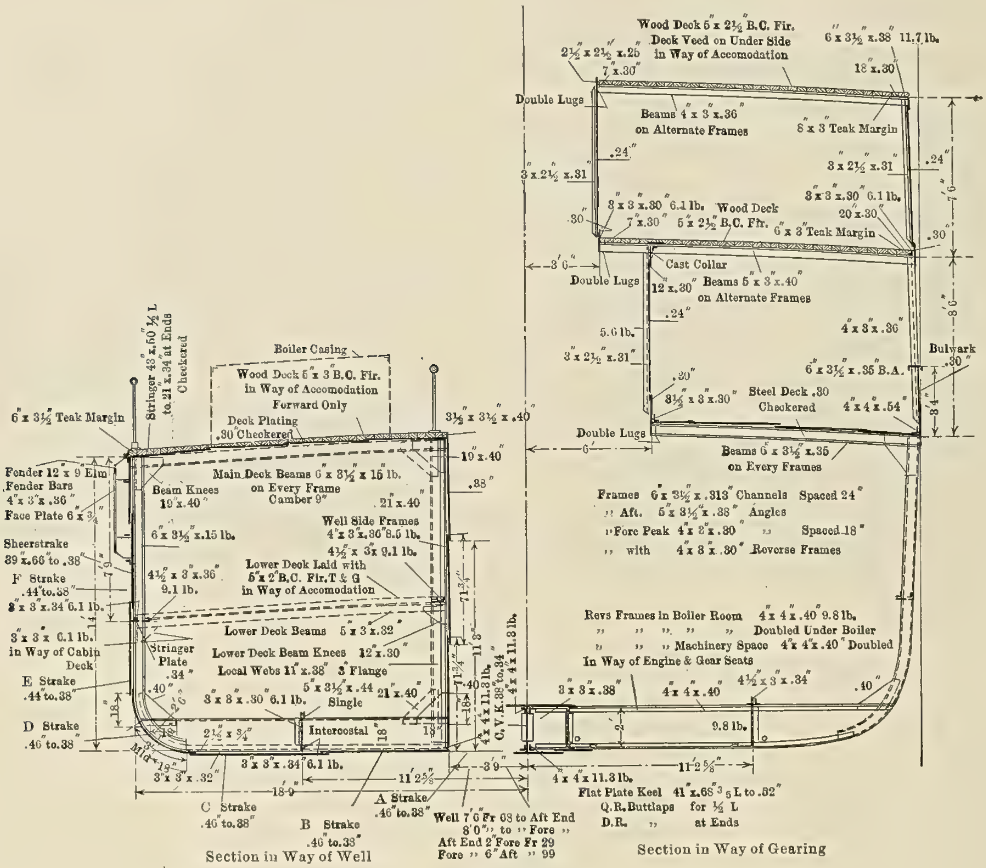


Fig. 4.—Midship Section

A very powerful engine and drum has been installed in the lower hold on the starboard side for handling the very heavy bucket ladder and its equipment. The engine is of the vertical type, with two cylinders 14½ inches diameter by 13 inches stroke, and, like the deck auxiliaries, operates with steam at 90 pounds.

Ladder Gear

The hoisting rope is of special plow steel, 1¾ inches diameter, and the drum on the hoisting engine has been made large enough to accommodate all the rope without riding. In addition to the main hoisting rope steel wire preventers 2¼ inches diameter are fitted to each side of the bucket ladder for use should anything go wrong with the side rods.

The hoisting sheaves are cast steel, 4 feet 6 inches diameter, specially arranged to take the above cable, the bottom and top blocks having five sheaves each, while a special idler sheave is

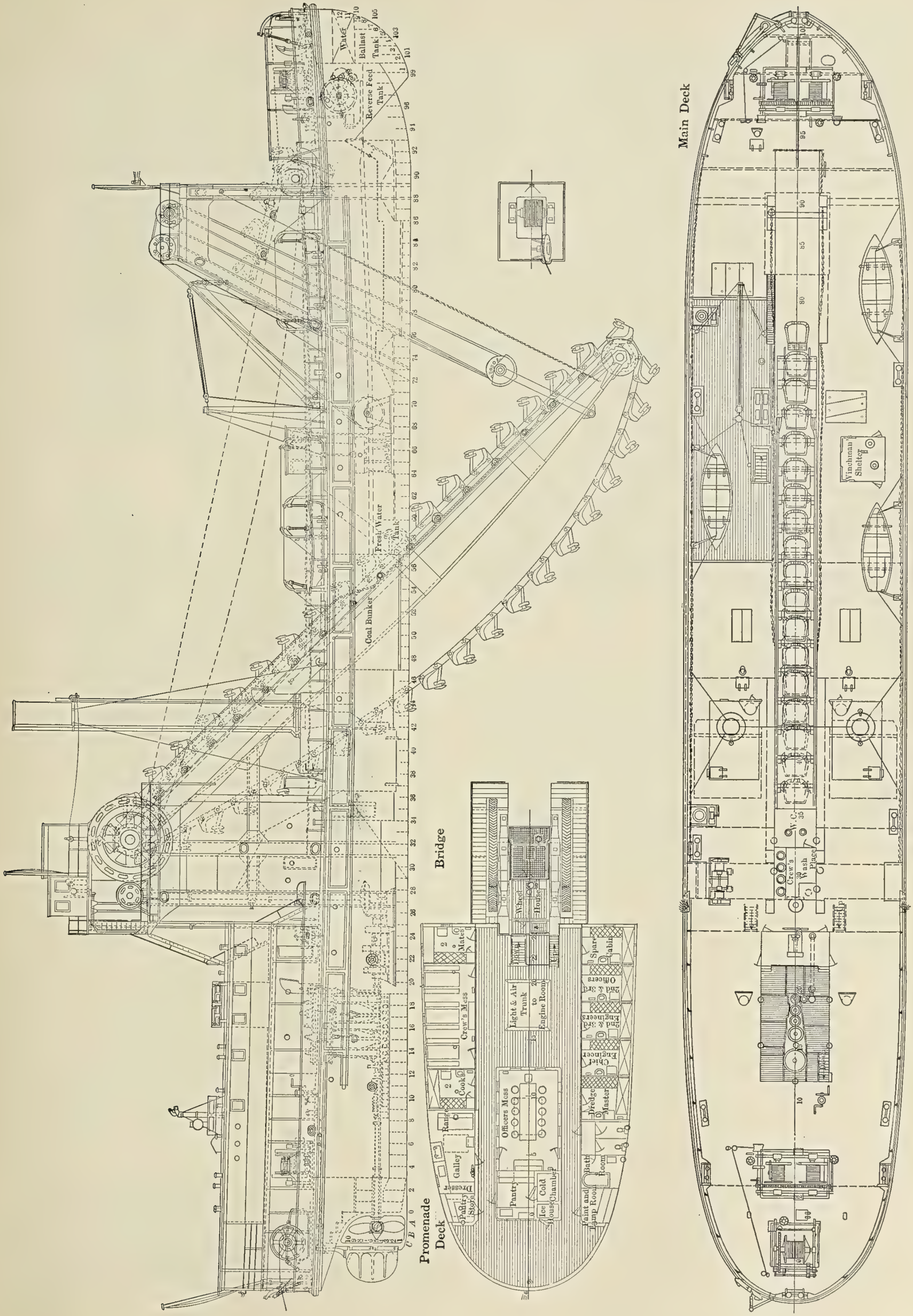


Fig. 5.—Profile and Deck Plans of Collingwood Dredge

fitted on the top of the bow shear legs. These shear legs and the main framing have all been specially designed to take care of the heavy strains which come on them owing to the massive design of the bucket ladder and the other dredging gear.

A winch 6 inches by 8 inches has been installed on the port side to handle the side chute. One side chute only has been fitted, but arrangements have been made so that in the event of the vessel having to discharge on the starboard side a chute could readily be installed. For handling barges two 8-inch by 8-inch capstans have been installed on the main deck on the port side.

The steering gear consists of a 5½-inch by 5½-inch steam engine, situated on the upper deck inside the engine casing, the customary lead of chains, spring buffers, quadrant, etc., have been fitted. The gear is also arranged to operate by hand.

A steel derrick post with steel derrick is fitted on the port side of the main deck, and arranged in such a way that it can readily handle the bucket when these have to be changed. It is also arranged to serve the hatch over a workshop which has been fitted on the lower deck forward.

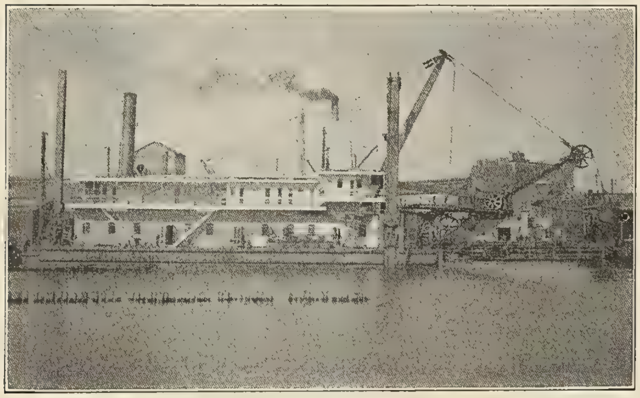


Fig. 1.—Panama Dredge *Paraiso* under Test at Port Richmond, N. Y.

ACCOMMODATIONS

The accommodation for the dredging master and officers is fitted on a promenade deck aft, and has been designed to give as much light and air as possible. The crew are accommodated with large rooms on the lower deck forward. These vessels usually work day and night throughout the season of navigation, and therefore accommodation for a double crew has been provided. Suitable galley, pantry, storeroom and lavatory accommodation has been installed, as shown on the accompanying plans.

The forepeak has been arranged for water ballast, and a reserve feed tank has been fitted immediately aft of this for use in case the vessel operates in salt water. Fresh-water tanks are incorporated with the ship's structure just forward of the coal bunkers.

Both ships were practically completed last autumn, but could not be delivered before the close of navigation owing to the poor delivery of important materials, and had, therefore, to be held until the opening of navigation this year. The first vessel successfully carried out digging and speed trials on April 23 and 24, under the supervision of Mr. McNab, assistant naval constructor; Mr. Forneret, chief engineer of the St. Lawrence Ship Channel, and Mr. Steadworthy, dredge master. The horsepower developed was 950 at 120 revolutions per minute, using steam at 180 pounds per square inch, which is well over the specified requirements. The trials of the second vessel, completed May 6, were equally successful, and both vessels left for the voyage to Sorel, P. Q., a distance of over 1,000 miles, on May 9.

Two New Dipper Dredgers at Panama

The *Gamboa*, the first of the two new 15-yard dipper dredges purchased by the Isthmian Canal Commission from the Bucyrus Company, started digging at the base of Hagen's slide on the west bank of Culebra Cut on April 3, and by the time this issue reaches our readers it is expected that the second dredge, the *Paraiso*, will be in action.

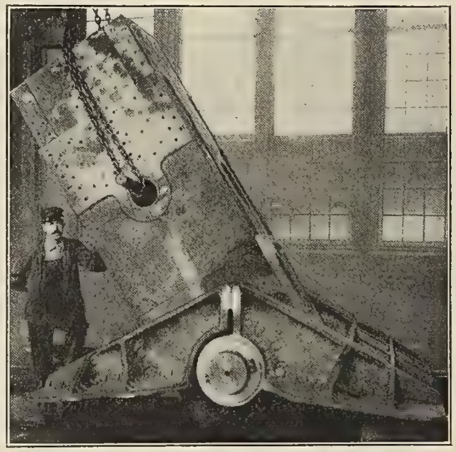


Fig. 2.—Spud Foot of the Panama Dredge

These dredges were fully described in our last dredge number. Suffice it to say that they are the largest dredges of their type that have ever been constructed. They are equipped with dippers of two capacities, one of 10 cubic yards for rock work, and one of 15 cubic yards for average digging.

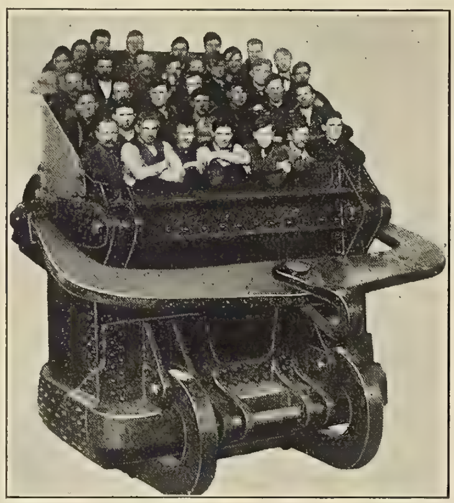


Fig. 3.—15-Yard Dipper, with 34 Men Standing on Platform Inside

An idea of the tremendous size of these machines may be gained from Fig. 3, which shows the 15-yard dipper. A platform has been suspended half-way down this dipper on which thirty-four men have been grouped. The dredges are de-

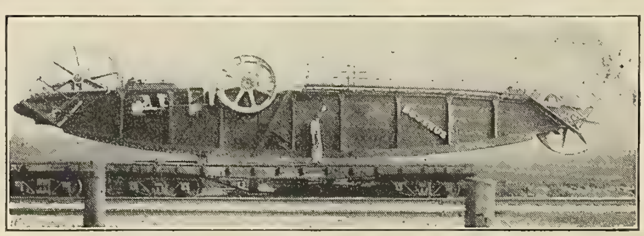


Fig. 4.—Boom for 15-Yard Dredge

signed to dig to a depth of 50 feet below the surface of the water. The booms are 62 feet long and weigh about 113,000 pounds apiece, complete with machinery. The dipper handle is 72 feet long and weighs 81,000 pounds.

The dredges were built at Newburg, N. Y., and towed down the Hudson River to Port Richmond, S. I., where they were erected and tested. Here they were again partially dismantled and towed to the Isthmus, the booms, handles, dippers and heavy parts being shipped separately on vessels of the Panama Railroad Steamship Line.

Powerful Bucket and Suction Dredgers for Russia

The bucket barge loading dredger *No. 2* illustrated in Fig. 1 is one of two dredgers delivered last year by Messrs. Simons, Renfrew, at Reval, to the order of the Russian Imperial Government. This dredger is fitted with two sets of compound surface-condensing engines, each driving its own propeller. Steam is supplied by two steel multi-tubular boilers, constructed to Lloyd's requirements for 120 pounds working pressure. The engines are arranged to give two speeds of buckets, so that either set is available for driving the dredging gear. The bucket ladder is designed for dredging the vessel's own flotation and to a depth of 40 feet below water level. The bucket dredging capacity is 1,000 tons per hour.

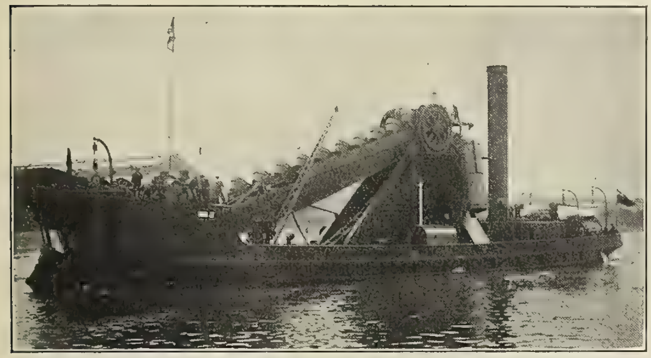


Fig. 1.—Bucket Barge Loading Dredger No. 2

These dredgers have been engaged in very onerous work. Each of them has raised many large boulders ranging in weight up to 5 tons without suffering in any way from the shocks inevitably sustained when dredging in hard ground largely mixed with massive boulders.

Fig. 2.—Suction Cutter Dredger No. 4

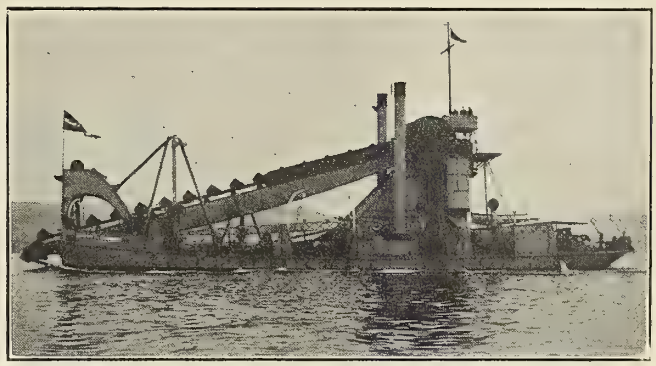
Fig. 2 illustrates the "Simons" cutter suction dredger *No. 4*, which these builders are on the eve of despatching to Russia. The dredger is fitted with two sets of compound surface-condensing engines, each driving its own propeller. Steam is supplied by two steel multi-tubular boilers constructed to Bureau Veritas requirements for 160 pounds working pressure. The dredging pump is driven by an independent set of triple-expansion surface-condensing engines. The cutter is driven from a set of vertical compound engines through cast steel gearing of very massive construction. The suction frame is designed for dredging the vessel's own flotation and to a depth of 40 feet below water level. The dredging and discharging capacity is 1,000 tons per hour. *No. 5*, a sister ship, is designed to dredge to a depth of 65 feet.

Bucket Ladder Dredger William H. Raeburn

Messrs. Ferguson Bros., Ltd., Port Glasgow, have just completed a self-propelling bucket dredger, named *William H. Raeburn,* for the Clyde Lighthouses Trustees. She is of the bow-well center bucket ladder type, 150 feet long by 34 feet beam and 12 feet depth, built to Lloyd's highest class.

Side shoots are arranged for discharging the dredged material over either side of the vessel into hopper barges, the lifting and lowering of each shoot being worked by an independent engine. The regulation of the spoil to either side of the vessel is controlled by a strong, flat valve door fixed at the apex of the shoots and worked by gear from the main deck.

Separate accommodation is provided below decks for the captain, engineers, crew and ladder men, all fitted up in first-class style, special provision being made for light and ventilation. The steering gear is fitted on the bridge, which is placed at the highest point of the dredger on top of the main gear framing.



Bucket Dredger *William H. Raeburn*

The main engines, which are employed for either propelling the vessel or driving the dredging gear, consist of one set of compound surface-condensing, inverted, direct-acting engines. An auxiliary condenser is fitted to deal with steam from the winches, etc. Steam is supplied from two cylindrical return multi-tubular boilers, constructed under Lloyd's special survey.

The bucket ladder is suspended independently of the upper tumbler shaft. Two sets of buckets are supplied, one for soft and one for hard material. The gearing is arranged to work the buckets at two different speeds according to the nature of material being dredged. All wheels, pinions, clutches, tumblers and bucket backs are of cast steel. The upper tumbler shaft is driven by two friction spur wheels of large diameter, and capable of being adjusted to convey the necessary power to the buckets according to the hardness of material being worked. The hoisting gear for the bucket ladder consists of a heavy wire-rope tackle, working in upper and lower sheave blocks suspended from a crosshead fixed on a box framing structure built into the forward end of the vessel. The lower sheave blocks are connected to the bucket ladder by strong forged side rods. The wire rope is wound on a large grooved

barrel driven by gearing from a double-cylinder engine, all placed below the deck. The dredging buckets and links are of a special strong design, each bucket having a capacity of 21 cubic feet. The connecting pins for bucket chain are of manganese steel.

Three powerful steam winches are fitted, two at the bow and one at the stern, for manipulating the mooring chains and holding the dredger up to its work. Each winch is driven by a two-cylinder engine. The dredger is capable of a speed of about 7 knots.

Sea-Going Hopper and Suction Dredger

The dredger illustrated, which has excellent sea-going qualities, made the voyage from the builders' works, Werf Gusto, Firma A. F. Smulders, Schiedam, to the Dutch East Indies under her own steam.

She has the following dimensions:

Length between perpendiculars	229.6 feet
Breadth, molded	36.1 feet
Depth, molded	16.4 feet
Hopper capacity	24,724 cubic feet
Dredging depth	16 to 32 feet

Her speed when loaded is 8½ knots in calm water with and against a current, with a coal consumption of 1.87 pounds per indicated horsepower per hour, deduction being made for ashes and cinders.

The hull is built entirely of Siemens-Martin mild steel, according to the prescriptions of the Bureau Veritas and under its special survey. The hull is divided into thirteen compartments by means of watertight bulkheads, extending to the deck and provided with sluice valves for pumping the bilge water.

The steam engines operating the propellers and the sand pumps are of the triple-expansion type, and each set is provided with a separate surface condenser, while there are two sets of separate engines to operate the air, circulating, feed and bilge pumps. The two engines operating the propellers have each a capacity of 450 indicated horsepower, making 165 revolutions per minute, each driving a propeller. The sand pumps are actuated by two triple-expansion engines, each developing 280 indicated horsepower, making 200 revolutions per minute.

Steam is supplied by two cylindrical marine boilers with return flame, each with two Morison furnaces, executed according to the rules of Bureau Veritas and having each a heating surface of 1,775 square feet, working at a pressure of 173 pounds per square inch.

The vessel has the necessary installations and accommodation for the European and native crew. There are two masts, each provided with a derrick; the derrick of the foremast is capable of lifting 8 tons up to a height of 10 feet above deck with an outside range of 8 feet, while the mainmast derrick has a lifting power of 4 tons. These two masts are provided with steam winches, while there is a towing hook aft of the vessel.

The dredger is provided with two separate sand pumps, having the various suction and force pipes so arranged as to be capable of working as follows:

First, to suck from the bottom while navigating to a depth of from 16 to 32 feet by means of one central suction pipe; fill her own hopper, dumping the spoil by the bottom doors.

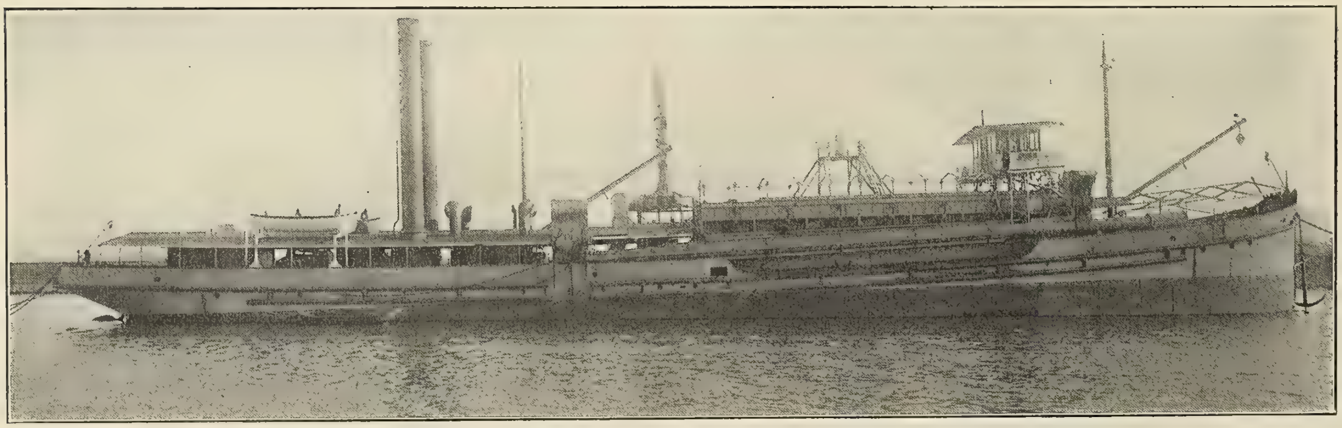
Second, to suck from the bottom with the starboard sand pump to a depth of from 16 to 82 feet by means of a lateral suction pipe; fill her own hopper or the barges moored alongside or force the spoil ashore by a floating pipe-line. In the latter case the starboard and port pumps can be coupled in series, in order to force the spoil to a greater distance.

Third, to suck from her own hopper, discharging or forcing the spoil as described in the second instance.

The vessel is provided with a complete electric light installation. The dynamo is capable of feeding the two arc lamps, placed on deck, each of 1,000 candle-power, as well as the necessary incandescent lamps for the cabins, engine room, stokehold and the lighting of the deck.

The bottom doors of the hopper are closed by means of two rods and chains operated by two hydraulic cylinders.

The sand pumps are capable of filling the hopper, which has a capacity of 24,724 cubic feet within about ten minutes with solid stuff when working in clayish soil, the two sand pumps sucking from the bottom by means of the central suction pipes with trailing suction head.



Sea-going Suction Dredger, Built by Werf Gusto, for Service in the Dutch East Indies

New Municipal Ferryboat Mayor Gaynor.—The *Mayor Gaynor,* built by the New York Shipbuilding Company, Camden, N. J., and recently placed on the New York Municipal Ferry Service between Manhattan and Thirty-ninth street, South Brooklyn, is 231 feet long over all, 45 feet 8 inches beam, molded at the deck; 64 feet beam over guards and 18 feet 6 inches molded depth. Propulsion is by a four-cylinder triple-expansion engine, with cylinders 21½, 33, 39 and 39 inches diameter by 30 inches stroke, designed to develop 1,950 indicated horsepower at 150 revolutions per minute. Steam is supplied at 225 pounds working pressure by three Babcock & Wilcox watertube boilers. The auxiliaries include an electric lighting equipment, consisting of two direct-connected generators of 25 kilowatts each. The designed speed of the ferryboat is 14 miles per hour.

Large Electrically-Operated Gold Dredge*

Details of the Construction, Equipment and Operation of the Latest and Largest, All Steel Electrically-Driven Gold Dredge

BY W. H. GARDNER AND W. M. SHEPARD

The gold dredge is essentially a hull or scow on which is mounted excavating machinery, screening and washing appliances for the recovery of the gold, and an arrangement for depositing the waste material sufficiently far behind the dredge as not to interfere with its flotation and operation. The dredge excavates material at its front end, extracts the gold and deposits the waste material behind it, continually moving forward and carrying its own pond with it, thus working any fairly level deposit independent of its elevation or proximity to the river or stream. A continuous influx of fresh water through a ditch, varying from 40 to 200 miners' inches,[1] depending on the kind of ground and the size of the dredge, counterbalances the losses through seepage or evaporation, and serves to settle the suspended clay and silt.

The excavation is done by means of an endless chain of heavy buckets, revolving over two tumblers mounted at the extremities of a long ladder, the upper tumbler being six-sided and acting as a positive driving sprocket for the bucket chain. In modern installations the lower tumbler is round, acting as an idler or sheave. The ladder is suspended at its lower end from a heavy gantry on the bow of the dredge hull, the raising and lowering of the ladder controlling the digging depth. The elevation of this ladder is controlled by a winch, called the ladder hoist winch, situated on the port side of the dredge. The lateral motion of the buckets is secured by swinging the entire dredge on one of the "spuds" as a pivot. This is done by means of lines run from two drums, the "swing winch," on the starboard side, connected through sheaves on the port and starboard bow to "dead men" on the banks. The continuously revolving bucket line is thus swung across the face of the bank for a width of from 190 to 300 feet, and at the extreme lateral limit of the swing the ladder is dropped and the side swing repeated. The revolving buckets thus terrace away the bank until bed-rock is reached, when the ladder is raised, the dredge stepped forward by swinging on alternate spuds, and the whole operation recommenced. These spuds, which are single sticks of lumber on the smaller dredges and of structural steel on the larger and more powerful dredges, are at the stern of the dredge and suspended from the stern gantry. On the *Yuba No.* 14, which is described in this article, these spuds weigh over 40 tons each, and are 60 feet long.

Fig. 1.—A View of the Yuba Gold Dredge No. 14 in Operation

The ascending buckets, full of gold-bearing material, are dumped over the upper tumbler into a hopper lined with heavy-wearing bars, where it is subjected to high-pressure sprays of water. The gravel is then delivered to the screen, a revolving cylinder sloping toward the stern and lined with perforated steel plates, in which it is continuously played upon by jets of water and is completely disintegrated. The sand, fine gravel, and gold particles are washed through the perforations into the distributor under the screen which serves to properly distribute the mass onto the gold-saving tables. These are in two banks, an upper and a lower, and are composed of fore and aft and 'thwartship sluices, lined with steel-shod sugar pine riffles, where the gold is caught and amalgamated by mercury. The waste sand is delivered from the tail sluices at the stern of the dredge, some of it

* From the *General Electric Review.*

[1] A miner's inch is approximately estimated at 1½ cubic feet per minute.

being deposited around the spud points to enable them to obtain a firmer hold, and the remainder dumped at some distance behind the dredge. The boulders and heavy gravel, which do not pass through the perforations, fall from the rear end of the screen into a chute, and are thence delivered onto the stacker belt. This endless belt carries the material up a long stacker, which is hung from the stern gantry of the dredge, and is finally dumped far to the stern, forming the extensive "rock piles" characteristic of a dredging field.

All these operations are controlled by three men. The winchman, in the "winch" or operating room above the swing

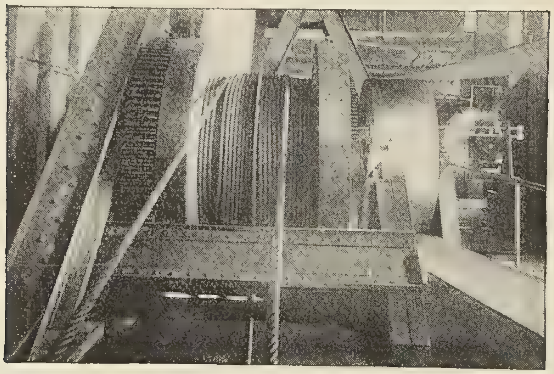


Fig. 2.—Ladder Hoist Winch

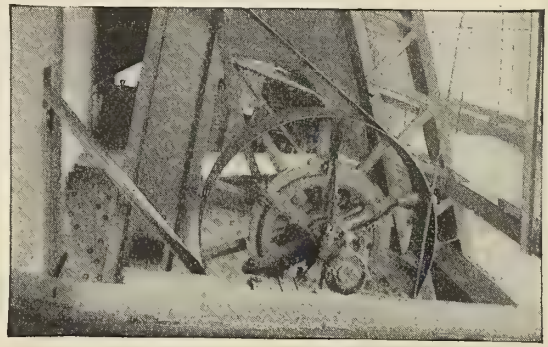


Fig. 4.—Screen Drive

winch, commands a view of the line of buckets and controls the principal motions of the dredge. Two oilers are employed, one of whom attends to the control of the screen and stacker, and they complete the necessary crew for a shift.

In 1912 the construction of *Yuba No.* 14, at present the last word in modern gold dredge construction, was first projected. It was determined to build this dredge entirely of steel, the longer life and practically negligible fire risk being the determining factors. The life of a dredge is limited by the life of its hull, and the steel hull, while more expensive, increases the life of the dredge from ten years, with a wooden

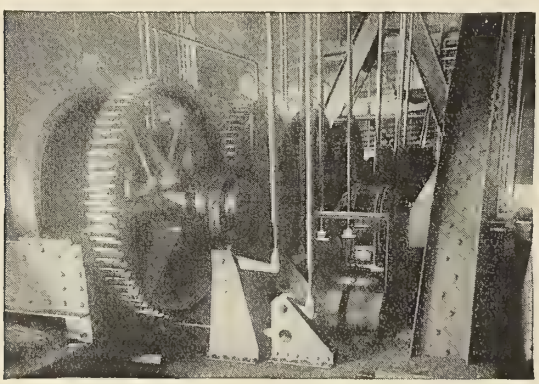


Fig. 3.—Eight-Drum Swing Winch

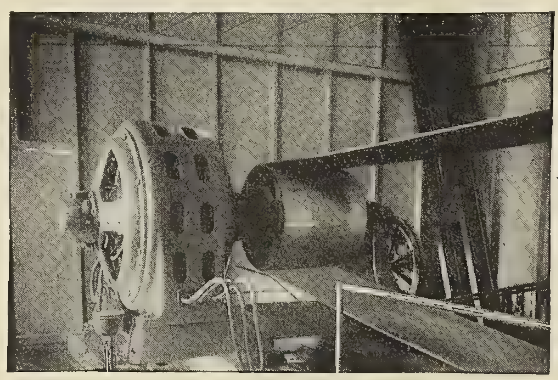


Fig. 5.—400 Horsepower Induction Motor, Operating Buckets

hull, to fifteen years or more. Steel housing and steel gold-saving tables were provided to decrease risk of loss by fire and for other reasons. Buckets of 16-cubic-foot capacity each were designed, the expected yardage being 10,000 cubic yards per day. A long ladder was planned, to enable the dredge to dig 70 feet below water level and reach the deepest bed-rock. The latest improvements in electrical equipment and control were incorporated in the plans of the dredge, to help reduce the operating cost to a minimum. An increased area of gold-saving tables was provided to secure the maximum gold recovery. While no experimental features were introduced in the design, the machinery was strengthened in many places. As a result *Yuba No.* 14 stands as the largest and most advanced gold dredge in the world.

Yuba No. 14 was designed and constructed by the Yuba Construction Company, of Marysville, Cal. It was built on the Yuba River, California, about 14 miles from Marysville.

Steel Hull

Perhaps the most important and interesting feature of *Yuba No.* 14 is its steel hull. This hull is 155 feet 6 inches long, 58 feet wide, with an additional overhang of 5 feet on each side to increase the deck area, and is 11 feet 6 inches deep. It is made entirely of steel, and is the first steel-hull dredge to have a deck of steel plating. Particular attention has been given to the design of the hull. It has been so constructed that all of the heavy stresses are distributed over a series of fore and aft and transverse trusses. The vertical sides of the hull form the girders which carry the concentrated loads near the edges of the main deck. The bottom of the hull is framed in such a way that the upward pressure of the water is carried to the main fore and aft trusses and to the sides, allowing the hull to be as light as possible, and yet giving it at the same time ample strength to withstand the stresses incident to the operation of the dredge. Following out this same scheme, the spuds are directly in line with the fore and aft trusses.

The bow gantry, the truss from which the ladder is suspended, is of particularly heavy steel construction, and the weights of the bow and stern gantry, added to the weight of the hull, show a grand total of 1,562,546 pounds.

The housing, carrying out the general plan of the dredge, is also of steel fireproof construction. It is made up of two sheets of 22-gage steel, between which is a ¼-inch sheet of

millboard. This insures absolute fire protection, and gives a maximum insulation, keeping the dredge interior warm in winter and cool in summer. This is an important item, for warm weather in the field is particularly torrid owing to the gravel and sand bars along the river.

Digging Ladder

The digging ladder, of the plate girder type, is one of the heaviest yet designed, and to enable the dredge to dig 70 feet below water level has a length of 133 feet 6 inches between tumbler centers. This girder is 10 feet in depth. Not counting the ladder rollers or bucket line, this ladder weighs 125 tons.

The bucket line is composed of 87 buckets, connected in an endless chain. The bucket bottoms are of a special nickel-chrome steel, cast with the hoods integral. The lips and bushings are of manganese steel, and the bucket pins are of a specially heat-treated oil-tempered nickel-chrome steel. The wear on the bucket line of a deep-digging dredge is very great, and hence only the highest grade steels can be used in its construction. This bucket line complete weighs very nearly 203 tons, a weight of over 4,600 pounds per bucket.

Ladder Hoist Winch

The ladder hoist winch, Fig. 2, is operated by the main motor through a pulley shaft on the main deck, this shaft being also belted to the main bucket drive above. The main digging motor, which is of 400 horsepower, is thus used to raise and lower the ladder and to drive the bucket line.

The main drive, consisting of the upper tumbler shaft with its two 12-foot diameter gears, the intermediate shaft, which is made in two separate lengths to allow room for the long hopper, and the pulley shaft, with its two differential pinions and 12-foot diameter pulley, is rigidly supported by the steel main gantry and the upper chords of the fore and aft main trusses, this rigidity serving to hold the gears accurately in mesh and to preserve the alinement of the shafting.

Screen

The screen, a revolving cylinder of perforated high carbon steel plates, is 50 feet 6 inches in length and 9 feet in diameter, and is stiffened by heavy longitudinal steel angles extending between the supporting tread rings at each end.

The gold-saving tables and supports are made entirely of steel, and divided into two separate tanks 6 feet apart. In each bank there are fourteen transverse sluices on each side of the dredge. The three upper sluices extend through the side of the house, where each one discharges into separate outboard longitudinal sluices that extend to the stern. The other eleven cross sluices discharge into seven inboard longitudinal sluices, the discharge from which is carried about 25 feet astern by overhanging steel tail sluices, or delivered back of the spuds as may be required. The total table area is 7,540 square feet.

Spuds

The two spuds are built up of structural angles and plates, have a cast steel point, are 30 inches by 60 inches in section and 60 feet long, and weigh together 160,800 pounds.

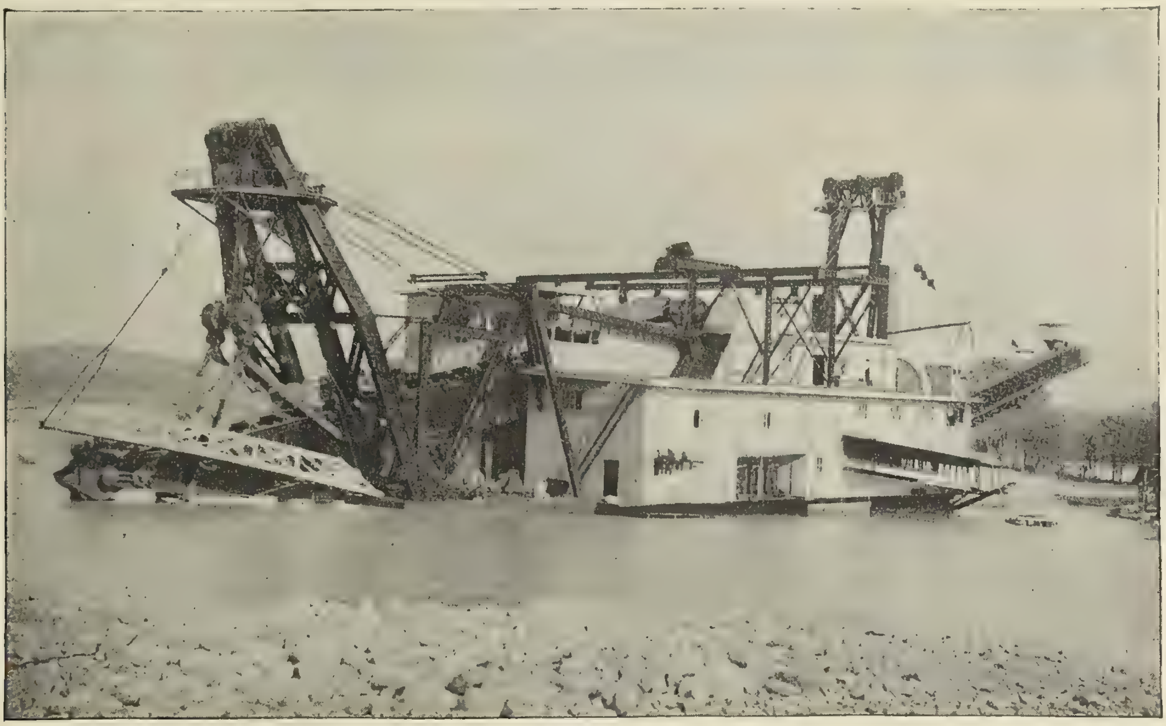


Fig. 6.—A View of the Yuba Gold Dredge, Showing the Digging Ladder Raised

The stacker is exceptionally long, measuring 137 feet between pulley centers, for when digging to the maximum depth of 70 feet the boulders have to be stacked very high. As is usual, it is of the lattice truss type.

Swing Winch

The swing winch, Fig. 3, is an eight-drum winch, two of the drums being for spares (lines which are used for repair work and miscellaneous purposes), two for the bow swinging lines, two for the lines that raise the spuds, and two for the stern lines. This winch weighs 41 tons. The design of winches of this type has been worked out particularly well, and in spite of continuous use and hard wear, repairs on such a winch are wonderfully small.

Pumps

Since *Yuba No.* 14 will not dig with a high bank, as do some of the Natomas Consolidated Dredges, no monitor pump is carried. There are, however, three Yuba construction pumps, one a 14-inch high-pressure horizontal centrifugal pump, used for supplying water to the screen, one a 14-inch low-pressure pump, used for supplying water to the tables,

and the third, a 6-inch two-stage pump, supplying water under a 125-foot head to the dump hopper.

By a system of levers, the motion of the drums on the swing winch, the speed change on the same winch, and the operation of the main drive clutch, the ladder hoist clutch, the ladder hoist brake, and the main drive brake, are all controlled from the winch room, requiring a total of twenty-three levers. These are in addition to the control of the main drive and swing winch motors. From the winch room the bucket line can be raised or lowered, stopped or set in motion, the spuds can be raised or lowered, and the dredge moved by either the bow swing, head or stern lines.

Electrical Equipment

The electrical equipment of *Yuba No.* 14 is of interest, in that it represents something of a departure from the equipment heretofore considered standard for California gold dredges. This departure from former practice was made in the light of experience gained in the operation of four dredges of the largest type, which were built by the Yuba Construction Company for the Natomas Consolidated, of California, and one similar dredge built for the Yuba Consolidated Gold Fields.

Power is supplied by the Pacific Gas & Electric Company, and is three-phase, 60-cycle, 4,000-volt.

The power is brought on board the boat through 750 feet No. O B. & S. gage, three-conductor cable. This cable is insulated for 4,500 volts working pressure. The shore cable is brought aboard the dredge on pontoons, and enters a switch house on the upper deck near the stern of the dredge, where there is installed an automatic 300-ampere, 7,500-volt oil switch with hand-operated remote control. There are installed in this switch house two 4400/110-volt, 200-watt potential transformers with fuses, and two 150-ampere current transformers. The secondaries of these transformers are connected to indicating instruments mounted in the winch room. From the switch house the current is fed through triple-conductor varnished cambric cable in conduit to the primary side of the main transformers. These consist of three 200-kilowatt oil-cooled transformers, 4,000-volt primary and 460/230-volt secondary. In addition to the main transformers, there is installed one 15-kilowatt 4,000-volt primary, 230/115-volt secondary oil-cooled transformer to supply lights. From the secondary side of the main transformers various feeder circuits supply the different motors, triple-conductor varnished cambric being used in iron conduits.

The control panel for the main drive, or digging motor, and for the winch motor, is located in the winch room, as is also the instrument panel. The instrument panel contains instruments the readings of which give the total input to the dredge.

The panels for the pump motors are located on the lower deck, the starting compensators for the pump motors being mounted alongside the panels. These compensators are all provided with inverse time-limit relays. The stacker and screen motors are controlled from independent panels located in the stern of the dredge.

Digging or Main Drive Motor

This motor, which is shown in Fig. 5, operates the digging mechanism. It is a 400-horsepower, 514-revolution per minute, 3-phase, 60-cycle, 440-volt, slip-ring, variable-speed induction motor with three bearings, pulley and sliding rails, with a master controller and contactor panels, and is provided with resistance good for continuous operation at all speeds from 50 percent normal to normal.

The contactor equipment is provided with current limiting relays, which limit the maximum load that the motor can take, and so protect both the motor itself and the complete digging mechanism that it drives. This is of considerable importance in keeping down the cost of repairs and preventing loss of time incident to repairs. The digging mechanism is subject at times to sudden and excessive loads, and without the current-limiting feature provided by the contactor control the only protection would be given by the overload oil switch. Due to the annoyance of having this switch tripping out frequently it is usually set so high as to afford little protection. The current-limiting relays also protect the motor and digging mechanism when starting. The winchmen can throw the master controller to the full "on" position, and the motor will come up to speed at a predetermined rate, which will not impose excessive stress on any part of the mechanism.

Winch Motor

This motor operates the winch, raises the spuds, and swings the boat, and consists of one 35-horsepower, 600-revolution per minute, 3-phase, 60-cycle, slip-ring, variable-speed induction motor, with a controller and resistance for continuous operation at from 50 percent to full speed. The motor is provided with pulley and base. In a few instances on smaller dredges, motors of intermittent rating were furnished for operating the winch. These motors, however, have not been found suitable for this service, as the winch operates almost continuously.

Pump Motors

All the pump motors are squirrel-cage motors, the high-pressure pump having a 150-horsepower, 600-revolution per minute motor, the low-pressure pump a 75-horsepower, 600-revolution per minute motor, the 6-inch two-stage pump a 50-horsepower, 1,200-revolution per minute motor, and the vertical pump a 10-horsepower vertical motor. These motors are all direct connected to the pumps, and, with the exception of the 10-horsepower motor, are all provided with welded end-ring construction in the rotor.

Screen and Stacker Motors

These motors are of the slip-ring, variable-speed type, provided with resistance for continuous operation at from 50 percent to full speed and with reversible controllers. They operate at 600 revolutions per minute, the screen motor being 75 horsepower and the stacker motor 60 horsepower. In most of the former gold dredges these motors were of the constant-speed squirrel-cage type. However, in the more recent large dredges, due to difficulties sometimes experienced with squirrel-cage motors on account of the heavy starting conditions and the desirability at times of running for short periods at reduced speeds, slip-ring motors with resistances for two-minute starting duty were used. In heavy work, however, these were found too light, and for *Yuba No.* 14 resistances for continuous operation were installed and reversible controllers used.

There is provided a 2-horsepower, 1,800-revolution per minute, 3-phase motor with pulley and base for the repair shop on board the dredge.

Power Consumption

The operating time of a gold dredge is between 85 and 88 percent of the total time. The dredge operates night and day with three shifts. The load factor varies from 62 percent to 80 percent, depending on the character of the ground, and as the dredge operates practically every day in the year throughout its life, except the Fourth of July and Christmas, it represents an excellent load for the power company.

Yuba No. 14 was built in four months and four days from the driving of the first rivet, a remarkable time considering the enormous total weight of the dredge. All material was transported 14 miles from the railroad over uncertain roads by means of power tractors and trailers, by no means a small job when it is noted that the completed dredge weighs very close to 1,994 tons.

Fig. 1.—20-Inch Hydraulic Dredge *Niagara*, Operated by a 1,000 Horsepower, Triple-Expansion Engine

Digging Hard-Pan with a Hydraulic Dredge

In the last annual dredge number of International Marine Engineering, which was published in May, 1913, a detailed description was given of the design of the 20-inch hydraulic dredge *Niagara*, owned by the Duluth Superior Dredging Company, and built by the Bucyrus Company, of South Milwaukee, Wis. At the time this article was published the dredge was still under construction, but during the last year it has been at work in the Saginaw River, Michigan, and we are now able to give some details of its operation.

This dredge marks the latest advance in the design of a high-powered hydraulic dredge for very heavy service. It may be recalled that the machinery is driven by a 1,000-horsepower triple-expansion vertical marine type engine, operating at a speed of 200 revolutions per minute for pumping material through a 5,000-foot pipe-line elevated to a height of 10 feet above the water. In order to enable it to handle the hardest kind of material and to take care of the extremely high-water pressure developed, the pump is of special design. Exclusive of the engine it weighs 71,000 pounds, and is made of special Bucyrus nickel-chrome steel. The cutter driving machinery, it is claimed, is the heaviest ever put on an hydraulic dredge of this size, being a 12-inch by 15-inch double engine.

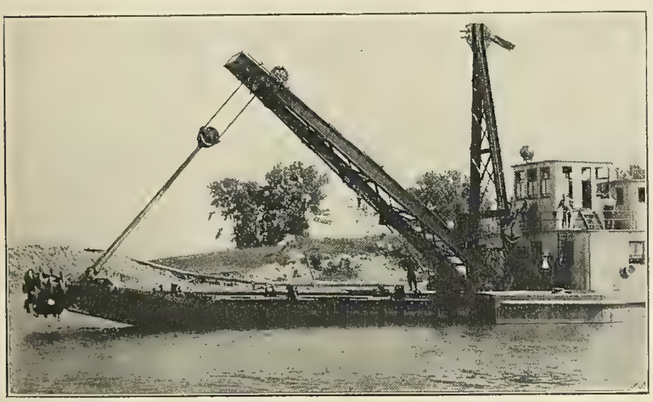


Fig. 2.—Cutting Ladder

The contract for dredging the Saginaw River between Bay City and Saginaw, Mich., was let by the United States War Department to George H. Breymann & Bros., Toledo, Ohio. The work was divided into two sections; Section 2 being sub-let to the Duluth-Superior Dredging Company, of Duluth. The total excavation amounts to over 4,000,000 cubic yards, of which 3,375,000 cubic yards are included in Section 2. The channel which is being excavated extends from the 18-foot curve in Saginaw Bay to the junction of the Tittabawassee and Shiawassee Rivers, a distance of 21¼ miles, and is to be 200 feet wide at the bottom and 18 feet in depth. The material encountered on Section 2 consists, for a distance of about 10 miles, largely of sand and clay; for the remaining 6 miles it is a very hard indurated clay or hard pan with a large quantity of stone of various sizes, very compact. The Duluth-Superior Dredging Company are working two 20-inch hydraulic dredges, the *Niagara*, mentioned before, and the *Enterprise*. The former is being used on the hard material on the lower end of the section, and the latter in softer digging, working from the middle up towards the upper end of the section.

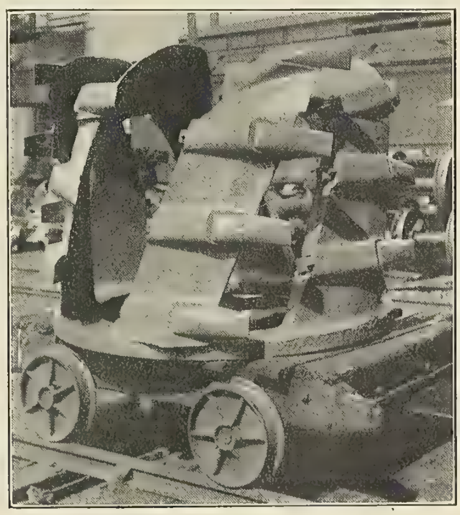


Fig. 3.—Cutter Head

The general plan of execution is similar to any other hydraulic dredging job. The material excavated from the

channel is pumped onto the bank of the river to form a levee upon which is to be built a road connecting the cities of Saginaw and Bay City. The *Niagara* started digging on June 5, 1913, and was kept at work until it was laid up for the winter on Dec. 23. During this period it worked 3,018½ hours, and was delayed for various reasons 1,008½ hours. All but 193 hours of the time charged to delays was consumed in shifting pipe-lines and in the other usual operations which necessitate stopping the pump. Of this 193 hours, the major portion was due to the wearing out of the pump casing and parts of the section and discharge pipes which pass through the hull, due to the unusually hard character of material pumped.

During this working season the dredge excavated a channel 14,600 feet long to a depth of about 17.5 feet, with an average width of 235 feet. The maximum depth of cutting was 7.4 feet, and the total amount of material removed 910,000 cubic yards, of which 730,323 was pay material, the remainder being taken outside of specified channel lines. The dredge *Enterprise* dug 940,000 cubic yards between April 22 and Dec. 13.

Drag Suction Dredger *Cormorant*

Trials of a Unique Drag Suction Dredger

The "Simons" drag suction dredger *Cormorant*, shown in the accompanying illustration, was delivered by Messrs. Simons & Company, of Renfrew, at Rangoon this year to the order of the Rangoon Port Commissioners for service in improvement work on the Rangoon River.

The *Cormorant* is fitted with a suction and discharge pump capable of raising and discharging 2,000 tons of material per hour. The dredging results obtained on the Clyde trials were very considerably in excess of the contract requirements, and the speed was found to be half a knot in excess of the specification.

Triple-expansion surface-condensing engines are fitted for driving the propellers or pumping outfit, as may be required. Steam is supplied from two cylindrical multi-tubular boilers, constructed for a working pressure of 160 pounds per square inch.

The main centrifugal pump is connected to a suction frame fitted in a central well at the stern, and powerful water jets are arranged on the nozzle at the bottom of the suction frame.

The hopper doors are controlled by powerful hydraulic gear, the power being supplied from one duplex set of steam pressure pumps. The hopper arrangements include "Simons" patent suction apparatus, which enables the load in the hopper to be discharged overboard for reclamation purposes, as well as through folding doors in the bottom by the ordinary method.

The "Simons" patent steering jets and "Simons" patent sand baffling arrangements are special features of this dredger, and the efficiency of both of these arrangements was amply demonstrated at the trials. In the teeth of a very strong wind the dredger was put on a mark and kept on a straight course for fully fifteen minutes solely by means of her hydraulic steering jets without any assistance whatever being rendered by the steering gear. With the starboard propeller running at full speed and with the port jet at full work the dredger was brought round against the propeller. Again, when all the way was off and the vessel at a standstill, a complete circuit was made by means of the steering jets.

The sand trapping arrangements with which the dredger was fitted were also found to be very efficient in reducing loss in the overflow from the hopper to a minimum when dredging light, silty material. It should be added that by the operations of the "Simons" drag suction dredgers a uniform and level bottom is obtained.

A Sea-Going Twin-Screw Barge-Emptying and Suction-Loading Dredger for Tientsin, China

An interesting barge-loading and suction-loading dredger, which has been built by Messrs. A. F. Smulders, of Schiedam, Holland, for the Hai-Ho Conservancy Board, Tientsin, China, is illustrated on page 247. This vessel has a length between perpendiculars of 124 feet 8 inches, a breadth of 32 feet 10 inches, and a depth of 10 feet 8 inches. It is capable of discharging spoil into barges alongside or through either a floating pipe-line, 1,000 feet in length, or a shore delivery pipe-line over a distance of 9,800 feet, and may be used as a suction dredger, working either at side anchors or in motion, and as a stationary pumping station for the discharge ashore of the spoil out of barges.

When pumping while in motion the dredger is arranged for discharge over either side into barges towed alongside, or through an opening in the bow, to which opening a floating pipe-line is fitted when dredging at side anchors. For balancing the vessel the shore delivery pipe-line is fitted on the port side, while the barge suction is usually effected over the starboard side. The suction pipe for direct dredging at anchor is provided with a suction mouth, armed with a sleeve, so

fitted as to avoid clogging when dredging a furrow 8 feet deep in easily collapsible earth. When the dredger is in motion the suction pipe is capable of reaching to a depth of 20 feet, and when dredging at anchors with a different suction mouth of reaching to a depth of 25 feet. The normal service speed is approximately 8 knots.

The hull is of Siemens-Martin steel, and built in accordance with Bureau Veritas rules and under special survey. It is divided into seven watertight compartments.

The two compound double-crank engines, with surface condensers for propulsion, each develop 250 indicated horsepower at normal speed. One of these is arranged to be uncoupled from the propeller shaft and coupled to a 22-inch water pump for the supply of water when the dredger works as a pumping station. The engines are fitted with link motion and reversing gear.

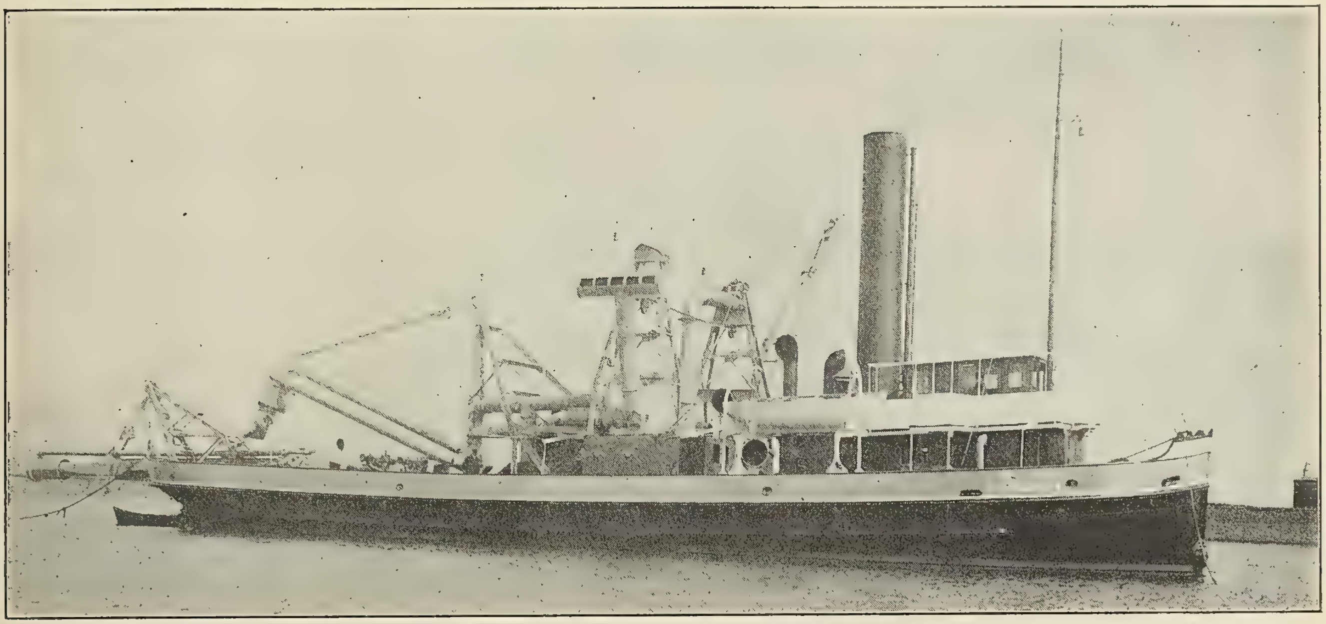
One compound double-crank engine, with surface condenser, developing 500 indicated horsepower when working at normal speed, is placed amidships for driving directly two sand pumps, working compound when emptying barges for shore delivery. The exhaust steam of the auxiliary engines is discharged in the condenser of the sand-pump engine.

The stern pump draws from the 24-inch suction pipe for direct dredging or from the 20-inch suction pipe for barge emptying. A stone-catching box is placed between the sand pump and the suction pipes; the mixture is delivered overboard into barges on either side or through the floating pipeline. An elbow is fitted instead of a pipe when the mixture has to go to the second sand pump, when both are working in compound for shore delivery. One compound, double-crank, high-speed engine drives directly a three-stage centrifugal pump for delivering water at the suction mouth at a pressure of 100 feet water column.

The main boilers, two in number, are of the marine type with return flues, and have a heating surface of 1,500 square feet each. The working pressure of the boilers is 120 pounds. A donkey boiler is fitted with a heating surface of 100 square feet, also working on a pressure of 120 pounds.

On deck are the suction pipe hoisting gear, the maneuvering winches, anchor davits, etc. An engine and dynamo of 100 volts, of sufficient power for six arc lamps and the necessary 16-candlepower incandescent lamps in the crew space, cabins, engine and boiler compartments, are fitted. Searchlight apparatus is provided, to be occasionally used instead of some of the arc lamps. When working as a pumping station the dredger discharges the spoil over a distance of 9,800 feet through a 24⅜-inch pipe-line, and delivers, by means of the sand pumps, 1,236 cubic feet of water a minute at 150 revolutions of the engine; while for the water pump the output is 1,271 cubic feet of water a minute with 160 revolutions of the engine. When dredging at anchors and discharging through a 1,000-foot floating pipe-line of 20 inches diameter, using one sand pump, the duty for the sand pump is 1,059 cubic feet a minute with 160 revolutions of the engine, while, when dredging in motion and delivering into barges alongside, the output of the sand pump is 2,471 cubic feet of water a minute with 150 revolutions of the engine.

This dredger is the ninth vessel which Messrs. Smulders have supplied to the Hai-So Conservancy Board. It would appear at first sight that in China manual labor for dredging would be much cheaper than mechanical work, but, despite the fact that Chinese labor charges are five times lower than in Europe, mechanical appliances have proved to be much below the cost of manual labor. This difference is brought about not only by reason of the high power developed in the dredging plant, but also by reason of the fact that coal is 50 percent cheaper in China than in Europe, and also the weather does not affect the general expenses with dredging machinery so much as human labor.



The *Chung-Hua*, A Dutch Built Dredger for China

Monthly Shipbuilding Reports.—The Bureau of Navigation, Department of Commerce, reports 118 sailing, steam and unrigged vessels of 40,326 gross tons built in the United States and officially numbered during the month of April. Of this total, eleven were steel steamships aggregating 28,152 gross tons. The largest vessel built during the month was the *Iowan* of 6,649 gross tons, built by the Maryland Steel Company, Sparrows Point, Md., for the American-Hawaiian Steamship Company.

Launch of the Howard M. Hanna, Jr.—The Great Lakes steamer *Howard M. Hanna, Jr.*, was launched at the Cleveland yards of the American Shipbuilding Company May 9. The dimensions of the vessel are 525 feet length over all, 54 feet beam, 30 feet depth, deadweight capacity 9,000 tons. The vessel will be operated by W. C. Richardson & Company.

The Powerful Rock-Lifting Dredger Cowpen

A Twin-Screw, Stern-Well, Bucket Hopper Dredger of 1,600 Horsepower Built for Service in Deepening Blyth Harbor

A powerful twin-screw stern-well bucket hopper dredger was completed towards the end of April, 1913, by Messrs. Ferguson Bros., Ltd., Port Glasgow, for service at Blyth Harbor, on the northeast coast of England, where a very comprehensive scheme of deepening and other improvements is now being proceeded with. The deepening of the harbor and entrance channel at Blyth involves the removing of a considerable amount of rock, consisting of hard sandstone intermixed with veins of metamorphic rock and large numbers of boulders.

The new dredge is 205 feet in length between perpendiculars, 41 feet breadth, molded, and 16 feet 9 inches depth, molded. She is capable of cutting her own flotation and dredging in any depths from her own flotation level down to 50 feet. The bucket ladder, 112 feet in length, projects beyond the hull a distance sufficient to enable the dredger to work close up to dock and quay walls when the buckets are lowered to a depth of 40 feet.

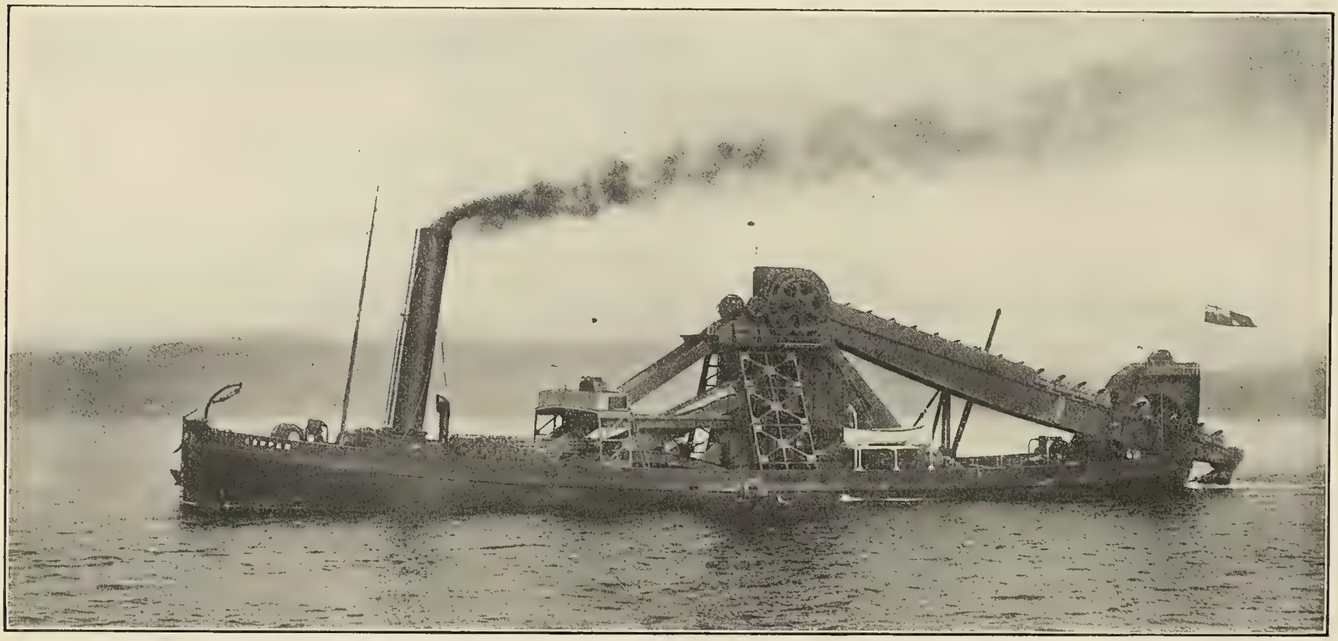


Fig. 1.—Twin-Screw Stern-Well Bucket, 1,000-Ton Hopper Dredger for Blyth Harbor

The hull is subdivided into 12 watertight compartments; the two sides of the hull at the after end of the vessel, where the bucket ladder projects, are strongly connected by raised framing constructed with heavy girder beams and strong bracing plates carried across the vessel above the ladder well. This framing is of a height to insure the sag of the chain of buckets being above the bottom of the vessel. The bucket ladder and box framing for supporting the chain of buckets and dredging have been constructed of the best class of girder work, all put together and efficiently connected with steel rivets closed by hydraulic pressure. A side shoot is arranged for discharging the dredged material over the starboard side of the vessel into the hopper barges, the lifting and lowering of the shoot being worked by an independent engine. The regulation of the spoil into the vessel's own hopper is controlled by 3 strong flap valve doors fixed in the hopper shoot and worked by gear from the main deck.

Separate accommodation is provided under the deck for the captain, engineers, crew and ladder men, fitted up in first-class style, and having a very complete outfit, special provision being made for light and ventilation. Steam steering gear is fitted on the bridge placed over the hopper. A complete installation of electric light is fitted throughout, large arc lamps being placed on deck for night work. The compartments at the forward end of the hopper are arranged as coal bunkers and boiler-feed tanks. The bucket ladder is suspended independent of the upper tumbler shaft.

The main engines which are employed for either propelling the vessel or driving the dredging gear consist of two sets of triple-expansion surface-condensing inverted direct-acting type, having 3 cranks and capable of indicating 1,600 horsepower; they are fitted with steam reversing gear, and have auxiliaries embodying all the latest improvements. Steam is supplied from two cylindrical return multitubular boilers, constructed under Lloyd's special survey. The dredging machinery is of massive design for working in the hardest materials that can be dealt with by bucket dredgers.

The three double-cylinder mooring winches are arranged one at the bow and two at the stern of the vessel. The hopper winches are situated at the forward end of the hopper, with separate double-cylinder engines. All the winches are constructed by the builders, and are of their well-known type for dredging purposes.

The hoisting gear for the bucket frame is of heavy construction throughout, the worm gear having been designed for continuous running under full load without overheating. The worm wheel is of phosphor bronze, the worm of forged steel. The main barrel is grooved to take the wire rope which leads to the blocks arranged on the after framing.

This dredger was built throughout by Messrs. Ferguson Brothers, Ltd., Port Glasgow, according to Lloyd's special survey and under the direction of Messrs. J. Watt Sanderson & Son, Newcastle-on-Tyne, the engineers to the Blyth Harbor Commission.

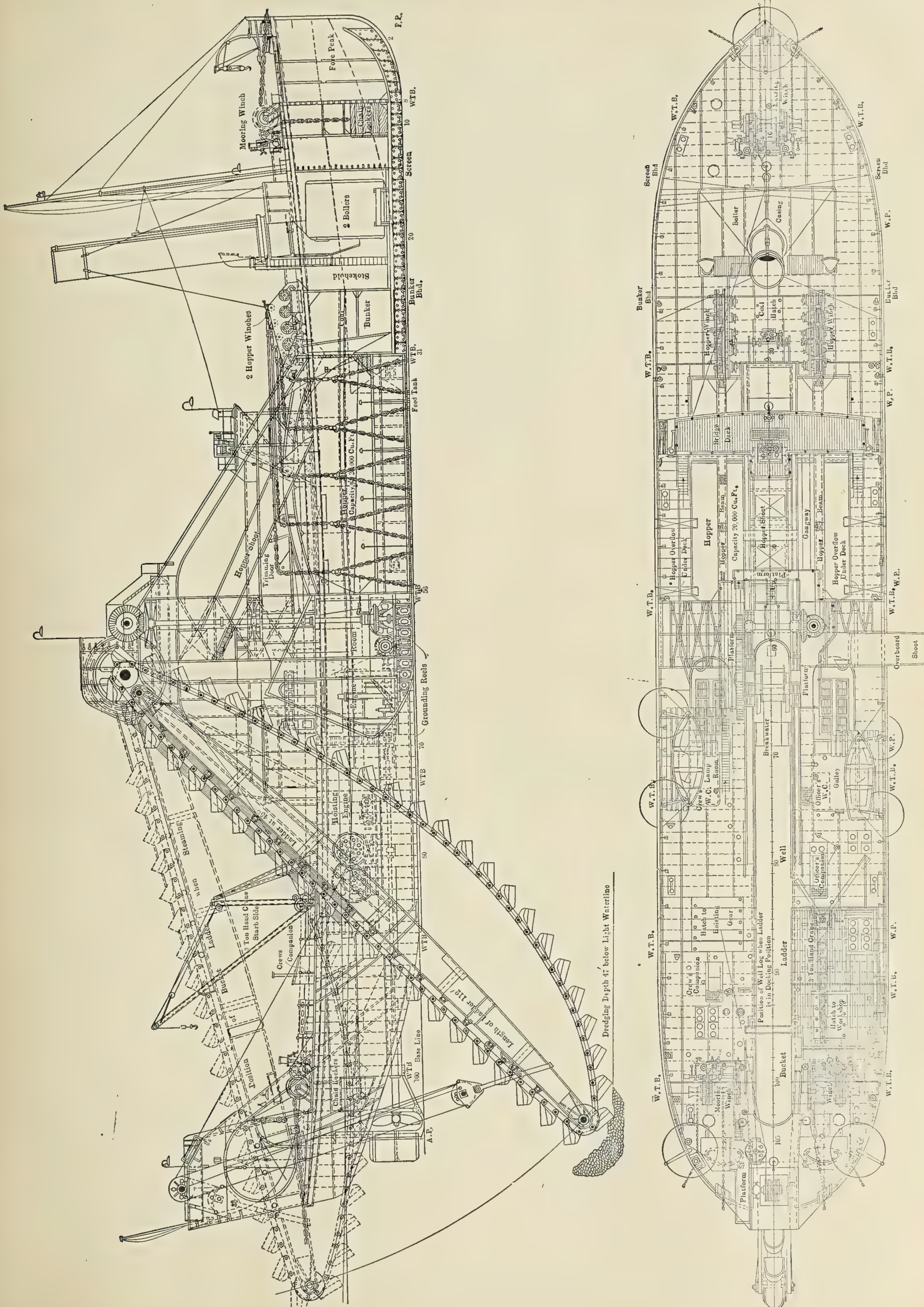


Fig. 2.—General Arrangement Plans of the Bucket Dredger *Cowpen*

A New Hydraulic Dredge for River Work in Cleveland

BY J. W. FELLMETH*

In order to reclaim 150 acres of valuable land in the suburbs of Cleveland, Ohio, it has been found necessary to change the course of the Cuyahoga River at a point where the river forms a horseshoe curve about 5 miles long. It is proposed to shorten this course by a straight channel approximately 2 miles long. Directly in the path of the new channel, however, is a hill which, together with the proper disposal of the excavated material, involves several quite difficult excavating problems.

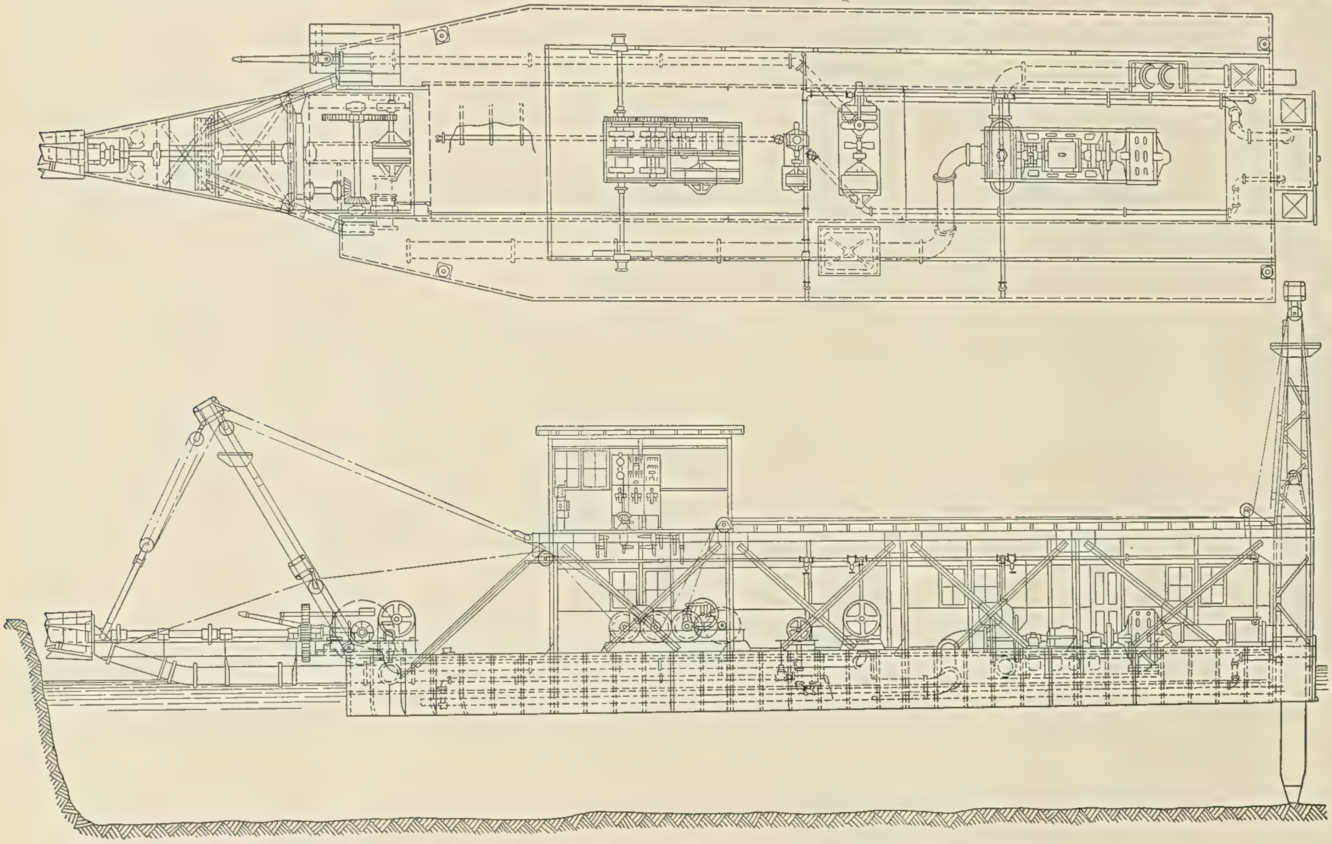
The method finally decided upon involves the use of a hydraulic dredge operating in connection with a hydraulic giant mounted under the bow of the boat. The purpose of the giant is to wash down the hill so that the dredge can pick it up and deliver it to the old river channel through a pipe-line that will vary from 200 to 2,000 feet in length. The new channel will be approximately 200 feet wide at the waterline, 12 feet deep, and with a bank of from 30 to 40 feet at various places.

The work of dredging will be done by P. T. McCourt, contractor, of Akron, and the special hydraulic dredge is now being built by The Marion Steam Shovel Company, Marion, Ohio. The dredge will be capable of delivering approximately 225 cubic yards of solid material per hour through a pipeline 2,000 feet long.

The illustration shows the general design of the dredge and the layout of the machinery. The dredge hull is built entirely of steel, and measures 80 feet long, 25 feet wide and 5 feet in depth. Two 4½-inch trusses are used for stiffness both fore and aft and for supporting the pilot house and the superstructure. The pilot house is situated so that the operator may at all times have an unobstructed view of the operation of the cutter, side lines, spuds and pipe-line. The control apparatus and all electrical appliances are placed in the pilot house, so that the operation of the dredge can be controlled by one man.

The machinery throughout is electrically driven by 2,200-volt, 3-phase, 60-cycle motors. The main dredge motor is of the variable speed type, of 300-horsepower capacity, with continuous rating and the necessary control for operating continuously at 25 percent speed reduction. This motor is direct connected to the main pump, which has 16-inch suction and discharge openings, and is mounted on a common bedplate. When operating at full load it will run at 345 revolutions per minute, at which speed the pump will deliver material at the rate of 12 feet per second through 2,000 feet of pipe.

A 6-inch, three-stage monitor pump is placed on the bow of the boat, and it will furnish water under pressure to the hydraulic giant for washing down the bank ahead of the dredge. This pump will be direct connected to a 200-horsepower constant-speed motor that will enable it to deliver to the nozzle 1,300 gallons of water per minute at an estimated pressure of 160 pounds per square inch.



General Design of Special Hydraulic Dredge, Showing Arrangement of Machinery

The cutter used in breaking up the material ahead of the dredge is of heavy cast steel construction, connected to a structural steel frame mounted on the bow of the boat, and driven by a 75-horsepower variable speed motor direct connected by a train of gearing. This motor will operate continuously down to 50 percent speed reduction. The winding machinery is also placed near the bow of the boat, and is used in raising and lowering the spuds, in swinging the cutter ladder from one side of the cut to the other, and in raising and lowering the cutter. This machinery is driven by a 20-horsepower variable speed motor fitted with a solenoid brake, which will quickly bring it to rest when the current supply is broken. A general service pump is mounted alongside the monitor pump, and is used in pumping bilges, hosing off the deck and for fire protection. This pump is driven by a

* Member American Society of Mechanical Engineers and dredge engineer, The Marion Steam Shovel Company.

20-horsepower motor direct connected by a flexible coupling.

The whole channel must be completed during 1914, and as it will be necessary for the dredge to operate both day and night, a searchlight has been mounted on a pedestal near the monitor nozzle so that plenty of light may be had for night operation.

20-Inch Electric Dredge St. Louis

A dredge interesting on account of its many novel features, and on account of the severe conditions under which it is successfully working, is the 20-inch electric dredge built by the Morris Machine Works, of Baldwinsville, N. Y., for the Kinser Construction Company for their work at East St. Louis, Ill.

The dredge is built with a wooden hull and deck-house. The hull is 133 feet long on the deck, 35 feet wide and 9 feet deep. The deck-house is 84 feet long, 27 feet wide and 12 feet high. The draft, loaded, is practically 5 feet, and the gross tonnage 575 tons.

The dredging pump has a 20-inch suction and discharge, with the shell, disk liners and runner of manganese steel. The shell is designed to accommodate runners of various diameters, from 50 inches to 60 inches, to be used according to the length of pipe-line and the elevation against which the pump is working. The main motor is a 1,000-horsepower, type I, 8-pole, 2,200-volt, 375-revolution per minute synchronous speed motor, arranged with continuous-duty resisters for a 16 percent speed reduction below full-load speed.

The winding machine is a seven-drum hoist, driven through machine-cut steel gearing by a 75-horsepower motor operating at 500 revolutions per minute, with a gear ratio of 34.5 to 1. The construction of the winder hoist is of steel throughout, of extremely heavy proportions, designed for a duty of 18,000 pounds pull per wire at a speed of 100 feet per minute. The frictions and brakes on these drums are all operated by air pressure, with the control located in the lever house, situated on the roof of the deck house. This makes a remarkably compact arrangement and one calling for very little physical effort on the part of the operator. All drums are grooved to fit the rope for which they are used.

At the time the dredge was designed the contractor expected to encounter a good deal of stiff clay, so a ladder with the customary cutter was provided. The cutter was driven by a 75-horsepower, 500-revolution per minute motor, similar to the winder machine motor, geared through machine-cut steel gearing with a gear ratio of 40 to 1. The control of this motor, as well as the winder motor, was located in the lever house, each being provided with resistances to give a 75 percent reduction in speed, operated through a 14-point controller.

The ladder was extremely heavy, weighing 60 tons, all parts being of steel construction. It was designed to dig at a depth of 35 feet at an inclination of 30 degrees, or in case of extremely deep water to dig 55 feet at an inclination of 45 degrees. During the first four months the dredge was operated with the cutter, but as very little clay was encountered it was decided to take off the cutter and a suction mouthpiece was put in its place.

There are two 6-inch two-stage centrifugal pumps direct connected to a 35-horsepower, 1,500-revolution per minute motor, furnishing water to fire lines, service lines, to syphons for draining the bilges and for priming the dredging pump. Two 3-inch vertical bilge pumps, driven by a 10-horsepower motor at 750 revolutions per minute, are located on deck. To furnish air for winder frictions and brakes one 50-cubic feet per minute double-cylinder air compressor is provided, with one 75-cubic feet per minute double-cylinder air compressor. A 30-kilowatt, 2,200- to 115-volt, 3-phase transformer furnishes deck lighting service and power to the motor generator for a searchlight.

Two 30-inch Oregon fir spuds, fitted with cast iron points, weighing 8,500 pounds, are installed. The spud keepers are of cast steel, made in halves so that the spuds can be removed readily. The spud frame and ladder "A" frame are both of structural steel guyed by steel cables to the hogging trusses, which are built onto the steel trusses extending the full length of the boat.

Power to drive the dredging machinery is supplied by the East St. Louis & Suburban Railway Company. It is carried from the power house to the shore along which the dredge is working, a distance of 2 miles, at 13,200 volts. The voltage used on all the machines on the dredge is 2,200. The transformers are located on a barge anchored at the shore. Armored submarine cables connect the transformer to the shore line and to the dredge.

The dredge was designed to operate either with spuds and swinging wires from the end of the ladder or entirely by wires without the aid of spuds. With the dredge working to a depth not to exceed 50 feet the spuds were used, but when it was found necessary to go deeper than this to get sufficient material the use of spuds was abandoned and cables used alone. For several months this year the dredge has been raising the material from a depth of 74 feet below the water surface, which is believed to be a record for a hydraulic dredge. The material is discharged to a height of 45 feet above the zero stage of the river, through 1,000 feet of pontoon pipe and a shore line varying in length of from 1,000 to 2,000 feet more.

The total pay yardage to date handled by the dredge has been 2,825,000 in seventeen months, or an average of 166,000 yards per month, a very good average when the extreme depth of water and unusual height above water against which it had to be discharged are considered.

The running time of the dredge has been remarkably good; whatever delays having been experienced were mainly due to conditions outside of the dredge. All parts of the dredge were designed with the view of giving hard, continuous service, and at the same time permit of rapid work whenever a renewal became necessary. Overhead trolleys were installed over the heaviest pieces of machinery. An instance of the value of the above is shown when on an occasion it was desired to change runners in the main pump. The pump was dismantled, the old runner removed and a new one put in its place. From the time the dredge shut down to the time it was again pumping material out on the spoil bank was just two hours and thirty-five minutes.

Safety First

The attention given at the present day by employers to safety devices for the protection of life and limb of employees in shops and factories has lessened the accidents due to carelessness on the part of employees as well as those due to no fault of their own. The unprotected emery wheels and grindstones in the shops in former days were a fruitful source of accident to the employee.

In the up-to-date shop of to-day all grinding wheels are enclosed in such a manner as to protect the employee from the flying parts should the wheel burst, and no longer do you see the projecting set screws securing pulleys to the shafting revolving around with the machinery in close proximity to the clothing of the workmen.

Some years ago the dungaree clothing of a workman in a machine shop, in the presence of the writer, became entangled with a projecting set screw on a shaft of a grindstone, and his clothing was wound round and round the shaft until he had nothing remaining but his shoes and socks. The set screw was then changed to prevent the recurrence of such an accident that might not always end so fortunately. J. E. C.

4-Cubic Yard Dipper Dredge Kewaunee

A Government Dredge Designed for Digging to a Depth of 25 Feet with an Output of Over 200 Cubic Yards per Hour

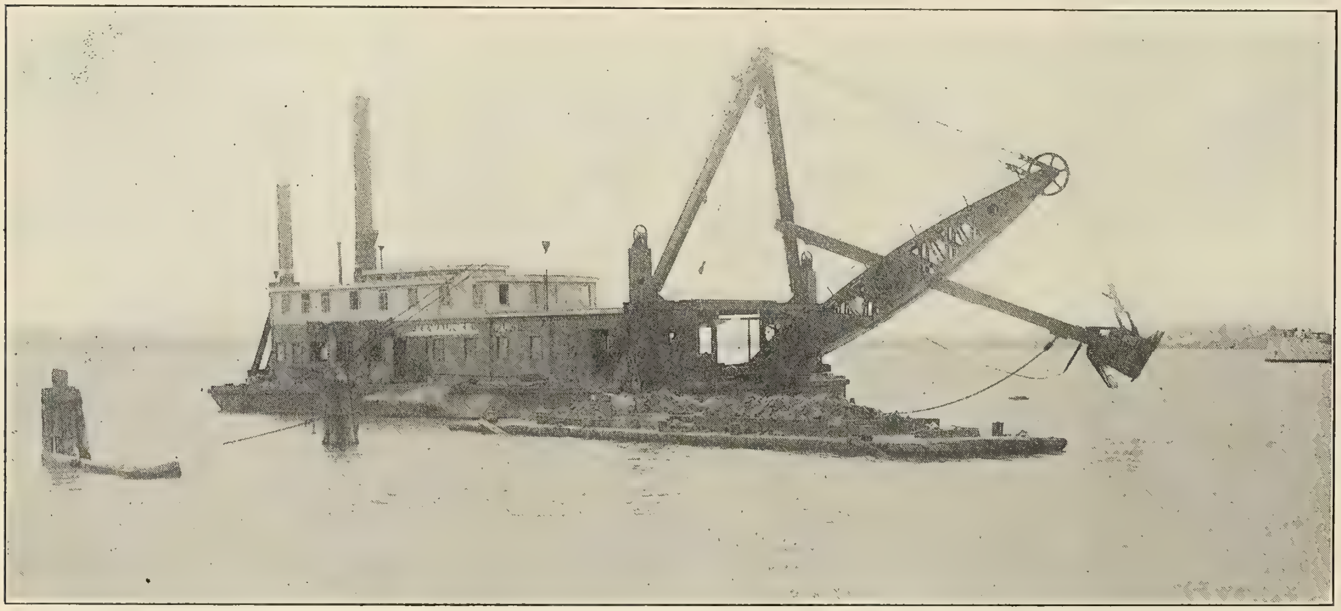
BY FRANK RENZENBERGER, M. E.*

The Marion Steam Shovel Company, of Marion, Ohio, has recently built for the United States Government the 4-cubic yard dipper dredge *Kewaunee* for use in the harbor at Kewaunee, Wis.

The dredge has a composite hull of the following general dimensions: Length, 100 feet; width, 34 feet; depth at bow, 9 feet 8 inches; depth at stern, 8 feet 8 inches; crown of main deck, 4 inches dead rise. The hull, built of open-hearth steel, is composed of transverse frames spaced 24-inch centers, with 6-inch channels for the bottom, deck and floor beams, and 6-inch by 3½-inch side angles connected to the floor beams by suitable gusset plates. An inboard girder is fitted between the bottom and floor beams, extending from bow to stern, and composed of a vertical plate with 3½-inch by 3½-inch angles top and bottom clipped to the transverse beams. There is also an outboard truss girder, extending from bow to stern, and fitted between the bottom frames and the main deck. In connection with the truss girder the longitudinal coal bunker bulkhead is also fitted between the beams, extending forward from the stern to a transverse bulkhead, located forward of the boiler room. There is also a second transverse bulkhead located forward of the main machinery, thus dividing the hull into three compartments fore and aft. The hull planking is of fir; the bottom 4 inches thick, sides 5 inches, the bow, the aft end and slope 6 inches, and the deck 3½ inches thick. All plank is fastened to the steel work with galvanized bolts. The boiler room floor, together with the floor around the main machinery, is composed of steel checker plates.

The forward spuds are of fir, 26 inches by 26 inches, stiffened by corner angles extending full length. The spuds are housed in steel casings, built up of plates and corner angles, and secured to the hull by heavy plate brackets. The casings are provided with open-hearth steel hinge castings for unshipping the spuds.

The stern spud is of fir, 20 inches by 20 inches, and is stiffened by corner angles extending the full length. It is of the walking or trailing type, and is mounted in suitable guides on the stern of the dredge. All spuds are provided with open-hearth cast steel points.



Government Dipper Dredge *Kewaunee*

The A-Frame and Swinging Circle

The A-frame is built entirely of steel with cast steel head and foot castings, and is 44 feet high above the deck. The foot of the A-frame is pin-connected to a cast steel step casting, securely bolted to a beam across the top of the forward spud casings. The head casting is of open-hearth steel, firmly riveted to the A-frame legs, and provided with a hammered steel journal pin for the A-frame yoke. The yoke is a single open-hearth steel casting, bronze bushed, and to it the boom guys are attached. The back of the A-frame head casting is provided with two large lugs to which the back guys are secured.

The swinging circle is 18 feet 4 inches diameter, and revolves on a steel base casting 45 inches in diameter. The circle is built up of plates riveted to the hub casting, to which the foot of the boom is hinged, and to which the cross braces supporting the channel rim are secured. The front of the swinging circle is left open in order to provide sufficient clearance for the dipper handle when the dipper is pulled back. The swinging cables pass around a steel casting, and are connected by long adjusting bolts for taking up the stretch in the ropes. The base casting is provided with a lip extending down over the bow.

The boom is of the double-bow trussed type, 45 feet long between centers. It is built entirely of steel and is provided with an open-hearth cast steel point and foot casting. The shipper shaft is of hammered steel, on each end of which the brake wheels are mounted. These wheels are provided with check bands lined with wood blocks; the ends of each band being connected to a rock shaft, which is operated by a lever

* Chief Correspondence Engineer, The Marion Steam Shovel Company.

at the foot of the boom. The manganese steel shipper pinions are mounted on this shaft, and engage the manganese steel rack on the dipper handle. The handle is held to the pinions by a yoke or saddle block, which consists of a cast steel reach block, to which is secured a steel frame carrying two sets of steel rollers, grooved to clear the rack bolts. The bearings in this block are provided with removable bronze bushes. The boom sheaves are 63 inches diameter, of open-hearth cast steel with machine turned grooves, and are bronze bushed and mounted on hammered steel shafts.

The dipper handle is 48 feet long, composed of two members, 7½-inch by 10½-inch fir timbers, armored with 7½-inch by 8-inch angles and bars, to which is secured the manganese steel rack. There is an open-hearth steel socket and adjusting casting. This is for pin-connection to the dipper so as to allow the pitch to be changed to suit the work.

Dippers

Two dippers were furnished with this machine, one of 4 cubic yards and the other of 2 cubic yards capacity. The entire front of each dipper is composed of a single manganese steel casting extending from the top to the bottom of the dipper and well around the corners, where it is riveted to the side plates. The front is fitted with four short teeth or points of manganese steel—no bases being used. The sides of the dipper are composed of steel plates, connecting the manganese front with the open-hearth steel dipper back, which is provided with lugs, to which the dipper handle, pitch braces and dipper hinges are attached. All pin holes in the dipper subject to wear are provided with removable bushings. Both dippers are provided with double doors.

Engines

The main engines are double, 14 inches bore by 16 inches stroke, of the horizontal stype and non-reversible. The bedplates are cast separate, and mounted on each side of a structural steel frame in line with the drum-shaft bearings. These engines are proportioned throughout for continuous heavy duty, and are fitted with a throttle of the balanced piston type with lowering control. The engine shaft is of hammered steel, and to it is keyed the cast steel engine pinion. The engines are compound-geared to the hoisting drum, which is provided with a differential barrel grooved for double ropes. This drum is mounted on a hammered steel shaft and is set directly ahead of the engines. The backing drum is mounted on a hammered steel shaft, and is placed forward of the hoisting drum to which it is geared, and both drums are actuated by frictions of the outside band type, set by steam. The cylinders for operating these frictions are attached to the spokes of the gears. All gears and pinions on the hoisting and backing machinery are of open-hearth cast steel with machine-cut teeth.

The swinging engines are double, 9 inches bore by 9 inches stroke, reversible by a central valve of the balanced piston type, and require but one operating lever. The engines are compound-geared to the swinging drum through a hammered steel intermediate shaft, set directly ahead of the engines. The swinging drum is grooved for rope and is keyed to a hammered steel shaft, the whole being mounted on a structural steel frame. All gears and pinions are of open-hearth cast steel with machine-cut teeth.

Spud Machinery

The forward spud machinery consists of two independent units, which are duplicates of the swinging machinery described above, with the exception that the intermediate shaft, in addition to the gears and pinions, is provided with a heavy brake for locking the spuds. This brake is lined with wood blocks, and is set by a powerful toggle lever so that the spuds can be locked in any position desired. The spuds are connected to the machinery by means of a double-hitch cable, and they are provided with sheaves on both the upper and lower ends, the cable passing around these sheaves and being connected to the castings on the spud casings, so that the spuds may be raised or the dredge pinned up as may be desired.

The aft spud machinery is mounted on a steel frame, and is provided with a double engine, 6 inches bore by 7 inches stroke, compound-geared to the spud drum through a hammered steel intermediate shaft. It is provided with a friction of the inside expanding type so that the drum can be disengaged for dropping the spud when desired. The outer rim of the friction housing is provided with a brake band for holding the spuds in any position desired—the connection to the spud being made by direct hitch.

The operating levers are banked in quadrants and placed so as to be within easy reach of the operator. They are placed well forward on the deck, so that the operator has a clear view of the work and practically the entire dredge under his control.

Boiler

Steam for all main and auxiliary machinery is furnished by one dry-back Scotch marine boiler, 9 feet 8 inches diameter by 16 feet 3 inches long, built for a working pressure of 130 pounds. It has two 42-inch corrugated furnaces and 108 3½-inch tubes. The boiler is lagged with asbestos and magnesia, 2 inches thick, and is covered with canvas. The stack, which is 34½ inches in diameter, extends to a height of 48 feet above the grates. The boiler is supplied with a full equipment of boiler fittings, feed, fire and water service pumps, injector and feed-water heater.

There is installed on the dredge a 5-kilowatt, direct-current generator, direct connected to a high-pressure, non-condensing steam turbine—all mounted on one bedplate. The lighting system includes a complete switchboard, with all wiring, conduit, fixtures and lamps for properly lighting all parts of the dredge, and including two arc lamps forward for night work.

For handling scows two independent vertical capstans, operated by double non-reversing engines, are located on either side of the hull. A full equipment of deck fittings, such as bitts, chocks, cleats, etc., are conveniently located on the deck.

The deck-house, which is built of wood, completely encloses the machinery and boiler. It is well lighted by large windows. The upper deck is fitted up with nine staterooms with double built-in berths. In addition to these there is an office, galley, pantry and a mess hall, capable of seating twenty-two men at one time. The dredge is also provided with lavatories, closets and shower bath. Steam is furnished to the heating system from the main boiler through a reducing valve operating down to 25 pounds.

The dredge is designed for digging to a depth of 25 feet below the surface of the water, and should have an output of from 200 to 250 cubic yards per hour in ordinary fair material. The dredge was erected at Milwaukee, Wis., and after making a successful trial run was taken to its present location, Kewaunee, Wis.

Annual Meeting of the Society of Naval Architects and Marine Engineers.—The next annual meeting of the Society of Naval Architects and Marine Engineers will be held in New York on December 10 and 11, 1914.

Summer Meeting of the Institution of Naval Architects.—The summer meeting of the Institution of Naval Architects will be held at Newcastle-on-Tyne, July 7 to July 10, at the invitation of the North-East Coast Institution of Engineers and Shipbuilders. In addition to the reading and discussion of papers arrangements will be made to visit some of the principal works in Newcastle and its vicinity.

American-Ball Four-Cylinder Triple-Expansion Dredge Engine

The dredge *Duwamish No.* 1 and two steel hull Government dredges, recently constructed on the Pacific Coast, are equipped with a new design of dredge engine, built by the American Engine & Electric Company, Bound Brook, N. J. The *Duwamish No.* 1 is in commission on the Duwamish Waterway, near Seattle, Wash., while the new all-steel Government dredges *Multnomah* and *Wahkiakum*, are operating on the Williamette and Columbia Rivers as far as Tongue Point, just above Astoria. These dredges, together with three older machines, will be able to deepen the channel in two years to a depth of 30 feet below low water.

The engine has a continuous capacity of 1,000 horsepower condensing, with an initial steam pressure of 250 pounds. The pump size is 24 inches, and the capacity is from 15,000 to 25,000 yards per day, depending on the material dredged. The length of the engine and pump is only 27 feet, and to the outside of the suction pipe 33 feet. The beam of the *Duwamish* is 40 feet, and of the two steel-hull dredges 38 feet. The length of the engine from the outside of the fly-wheel to the center of the coupling is only 14 feet. This length is practically the same as that of a vertical two-cylinder engine, whereas this engine has four cylinders—two vertical and two horizontal. If the four cylinders were vertical there would be five bearings instead of three, eight cranks instead of four, and the length would be correspondingly greater. The engine and pump would therefore have to be installed fore and aft.

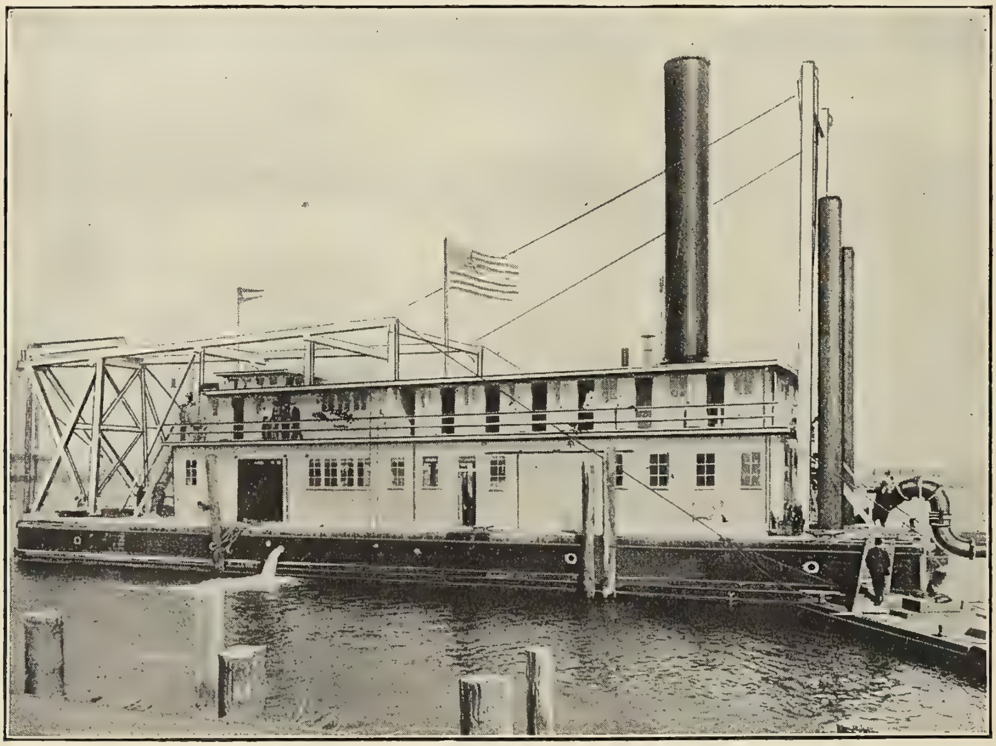


Fig. 1.—Dredge *Duwamish No.* 1

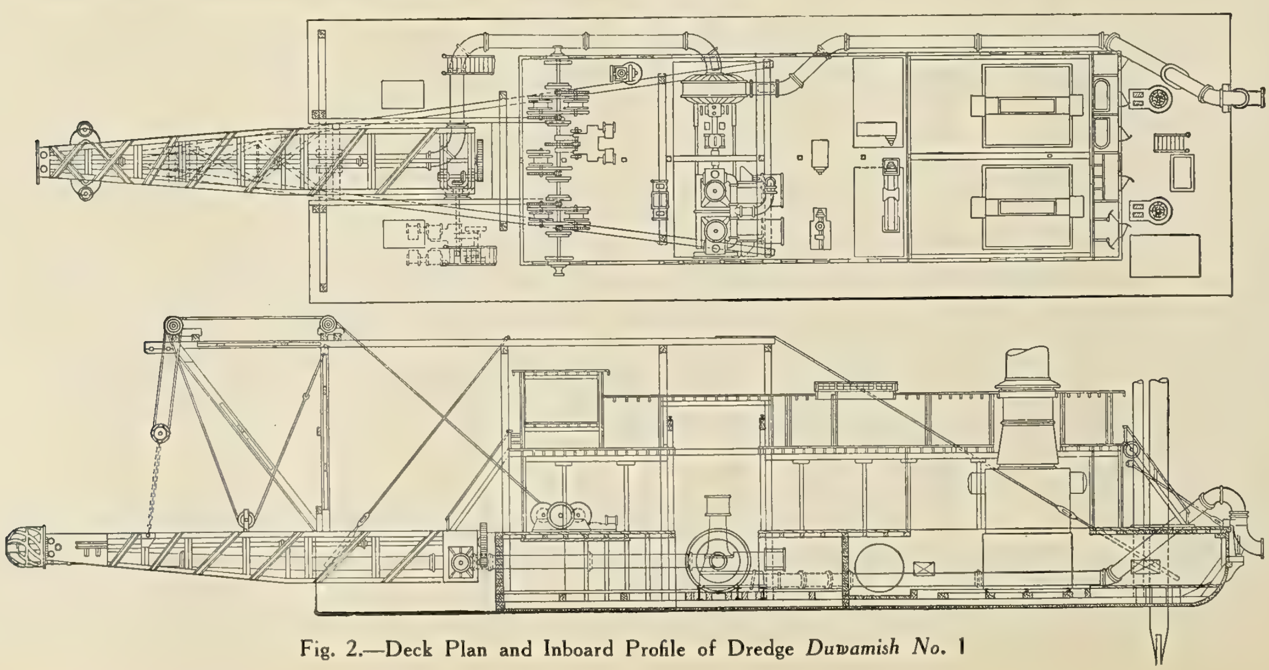


Fig. 2.—Deck Plan and Inboard Profile of Dredge *Duwamish No.* 1

The arrangement shown in the drawings is exceedingly compact. The engine utilizes the entire beam of the dredge for only a short portion of its length, and leaves large spaces forward and aft of the engine for other machinery. The hydraulic piping is not brought through the center of the dredge, but is entirely at one side, and does not cause interference with other machinery or piping.

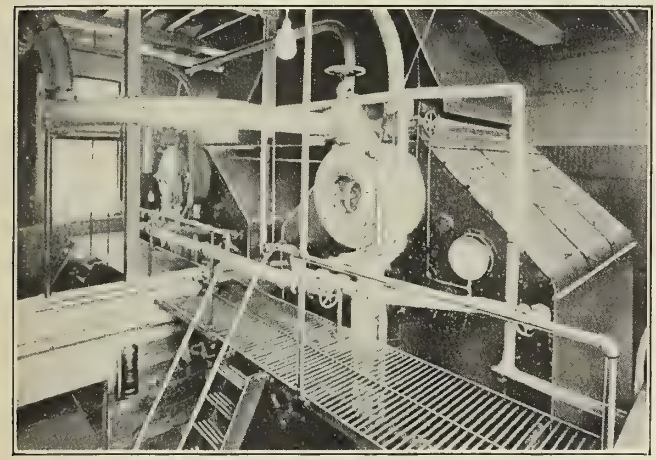


Fig. 3.—Boiler Room

The engine is of the angle type. In Fig. 6 the high-pressure cylinder, which receives steam at 250 pounds pressure, is shown in the foreground, the intermediate-pressure cylinder to the right of this, while the two low-pressure cylinders are vertical. This construction not only gives a large ratio of expansion, and therefore high economy, but eliminates an enormous low-pressure cylinder with its massive reciprocating parts. With a single low-pressure cylinder the speed would have to be materially reduced, and this in turn would increase the size, weight and space required by the engine. By reducing the expansion ratio and using a smaller low-pressure cylinder, higher speeds may be attained but economy is sacrificed. Thus the American-Ball four-cylinder triple-expansion engine shows an economy several pounds better than the three-cylinder vertical. Furthermore, with the four-cylinder angle construction the engine balance, it is claimed, is perfect, and higher speeds may be used, since the inertia forces of the horizontal reciprocating masses are opposed and balanced by equal and opposite forces from the vertical cylinders.

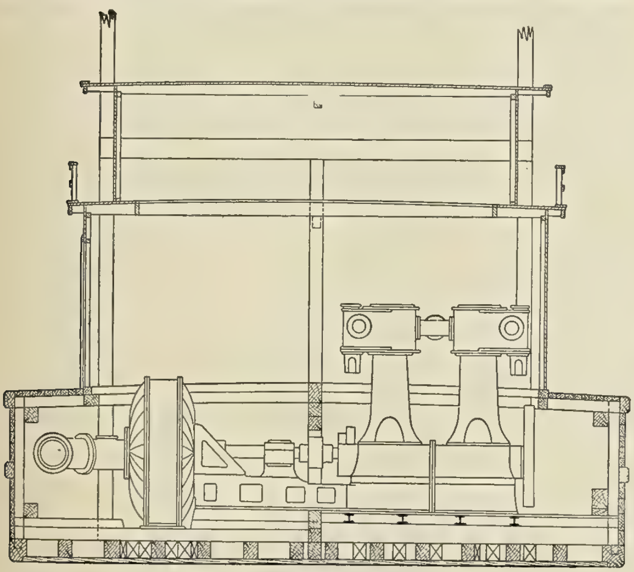


Fig. 4.—Midship Section

Owing to the freedom from vibration and pounding stresses the support for the engine is very simple, and consists, as may be seen in the drawings, of a simple cradle of I-beams. There is no special stiffening of the dredge, which, in the case of the *Duwamish,* is built entirely of wood.

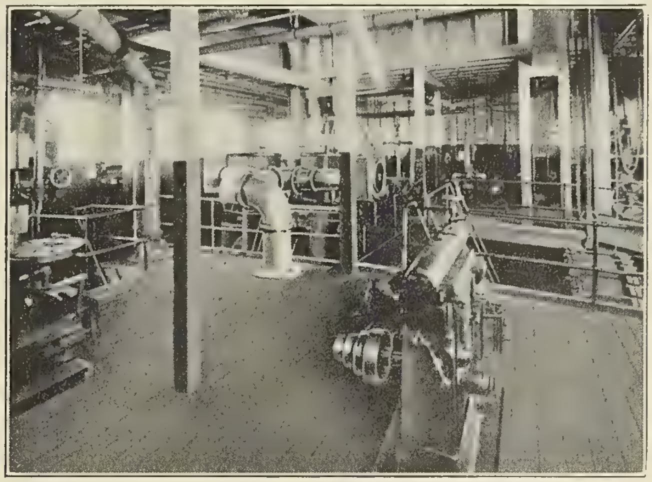


Fig. 5.—View on Main Deck in Machinery Space

The details of engine design are in general similar to standard American-Ball engines. Mention should be made of the oiling system. All parts are supplied with oil from two central storage tanks, which may be seen in Fig. 6 between the two vertical low-pressure cylinders. The oil collects by gravity, is filtered and then returned to the elevated tanks by two pumps operated by the valve gear rocker arms of the horizontal cylinders. One of these pumps with its plunger can be seen to the left in Fig. 6. The governor is of the standard American-Ball inertia type.

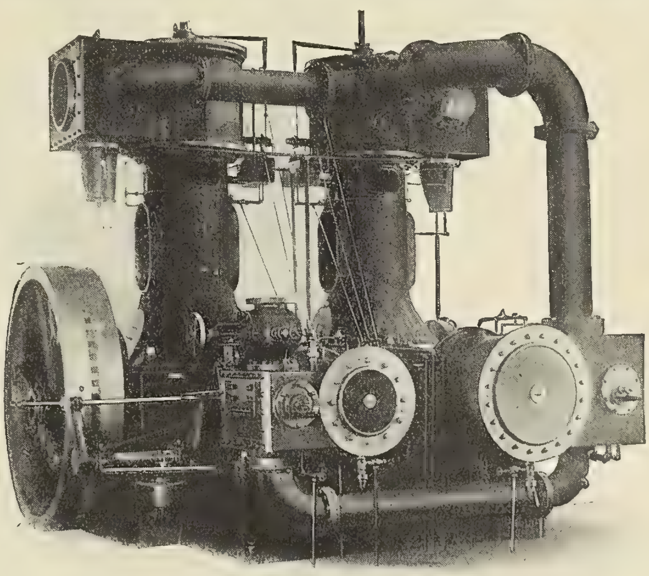


Fig. 6.—The Main Engine

The engine shaft is connected to the pump shaft by a jaw coupling. A heavy pedestal, shown in the cross section, carries two large pump shaft bearings. This construction takes strains off the engine shaft and gives ample stiffness to the pump shaft which carries the heavy overhung impeller as a cantilever.

The pump shown in Fig. 7 is of the Lockwood patent. The main feature in the construction of this pump, from the mechanical standpoint, is the ease of renewal of wearing surfaces; that is, the liners of the casing, especially the interior

of the peripheral surface, against which the heavy solids are thrown by the impeller. The blades of the impeller, or runner, are held between two face plates, and alternate blades extend from the rim to the hub, the others extending about halfway. Short vanes are attached to the outer surfaces of the impeller to project sand and water from the clearance space between the impeller and casing, which would otherwise become clogged and cause serious wear of both the lining of the casing and of the runner itself.

The cutter head of the dredge is built of special hard steel, and is of the spiral knife type, built to work in any kind of

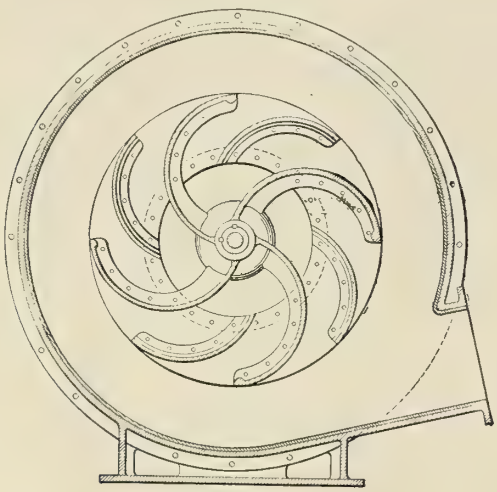


Fig. 7

material that can be loosened without blasting. It works in sand, cement, gravel, hard pan, or any refractory material short of solid rock.

The cutter engine, located in the bow of the dredge and opposite the piping, is a double-tandem compound engine of 250-horsepower capacity, driving the cutter through bevel gearing. The winding engines are simple, cross-connected double engines, and are located just behind the main winding gear shaft.

The dredge is fitted with a surface condenser built by the Seattle Construction & Dry Dock Company, and maintains a 25-inch vacuum. All auxiliaries exhaust into this condenser. A horizontal, direct-acting, combined pump handles both air and water.

The boiler equipment comprises two Ballin marine boilers, manufactured by the Ballin Boiler Company, Portland, Ore., having 7,000 square feet of surface, arranged for burning oil. Two large cylindrical oil tanks are located between the boilers and the main engine.

Besides the foregoing equipment there is an engine-driven generator, which supplies electric lighting throughout the dredge and arc lights on the forward deck for operation at night.

The *Duwamish,* and also the Government dredges *Multnomah* and *Wahkiakum,* are built from the designs of Mr. J. B. C. Lockwood, member American Society Civil Engineers, to whom we are indebted for drawings and photographs. The dredge *Duwamish* was guaranteed by its designer to have a capacity on its builder's trial run of 400 cubic yards per hour. This was largely exceeded, and during the test, which continued through 326 hours 30 minutes' actual running time, the average output was 714 cubic yards per hour. The dredge proves to have a capacity about double that of standard 20-inch machines working in similar material in the same vicinity, and proves beyond question that the 5 4/10 cents per cubic yard contract price for excavating 7,000,000 yards from the Duwamish Waterway is a profitable one.

Priestman Grab Dredger

Early in 1913 Messrs. Priestman Bros. Ltd., Hull, built for the port of Antwerp Authorities the grab dredger *Watergeus No.* 3, illustrated on this page. The length of the vessel is 174 feet, the beam 28 feet 6 inches and the hopper capacity 800 tons. It is fitted with four 5-ton Priestman grab dredgers, the capacity of each grab being 70 cubic feet. The trials of this vessel took place at Antwerp between June 25 and July 19, 1913, with the following results:

The coal consumption was about .125 pound per foot, and the economy was found to be 30 percent better than when dredging with bucket dredgers. The average output was 10,000 cubic feet per hour. In working 150 hours the four machines lifted 1,450,000 cubic feet of mud.

Grab Dredger *Watergeus No.* 3

Twin Screw Sand Pump Hopper Dredger Leviathan

The most powerful dredger in the world is the twin-screw sand pump hopper dredger *Leviathan*, built by Messrs. Cammell Laird & Company, Ltd., of Birkenhead, for the Mersey Docks and Harbor Board. Her dimensions are: Length, 476 feet; breadth, 69 feet, and depth, molded, 30 feet 7 inches. The total deadweight carrying capacity is about 11,000 tons on 23 feet draft. The propelling machinery is placed aft, and consists of two sets of triple-expansion engines. Steam is supplied by four large single-ended boilers and the vessel's speed is 10 knots when fully loaded.

Immediately forward of the boiler room are the pumping engine rooms, which contain four sets of triple-expansion engines, coupled direct to four centrifugal pumps capable of pumping a full cargo of 10,000 tons of sand from a depth of 70 feet below the waterline in fifty minutes.

Sand Dredge *Leviathan*

There are twelve hoppers, having a total cubic capacity of 180,000 cubic feet, arranged forward of the pump room. Along the top of the hoppers and extending for their entire length are two landers with two valves to each hopper worked by hand gear, so that any of these valves may be closed or opened, and thus regulate the trim of the vessel when pumping. The discharging of the spoil from the hoppers is carried out by Lyster hydraulic discharge valves. These valves are large, hollow cylinders fitted in the center of each hopper, covering circular openings 5 feet 6 inches diameter in the bottom of the hoppers. When discharging, the valves are raised 4 feet by hydraulic power worked from the fore-and-aft bridges by hand levers, and the spoil in the hoppers rushes out through the openings at the bottom. When dredging, the surface water is disposed of by flowing over weir plates, which can be adjusted to suit the trim of the vessel and thence overboard through large regulating trunks passing through the sides of the ship, two at each side, the sand settling to the bottom of the hoppers. When the vessel is fully loaded and the pumps are stopped, any remaining surface water is drained off by surface valves on the top of the Lyster discharge valves.

The dredging apparatus consists of four suction pipes connected to the pumps through the ship's sides. The pumps have sluice valves which can be shut off when the pumps are not in operation, the pipes are then hoisted upon the deck by four powerful winches. The suction pipes slide up or down on frames fixed on the ship's sides, and eight large jibs are used for hoisting, one at each end of the pipe. When the pipes are hoisted up to the deck there are deck slides, worked by a worm gear, which carry them inboard. In addition to the pipe hoisting winches there are four large steam winches for warping purposes, and also for use in case of emergency if the pipe-hoisting winches break down.

The vessel is equipped with powerful double steam winches, hand and steam steering gear, electric lights, etc. Comfortable accommodations are fitted up for the officers and engineers in the poop and for the crew in the forecastle, while a house for the dredging masters is provided on the navigating bridge.

TESTIMONIAL TO SYDNEY F. WALKER.—At the annual meeting of the South Wales branch of the Association of Mining Electrical Engineers last month, Mr. Sydney F. Walker, well known as a frequent contributor to these columns, was presented with a testimonial in the shape of a handsome gold watch as a token of esteem and respect, in connection with his presidency of the South Wales branch of the Association for the four first years of its existence. The watch bears an engraving to the above effect and was presented by the president of the branch, Mr. Godfrey Williams, of Aber Pergwm, a large colliery owner in Glamorganshire.

CAPE COD CANAL.—According to an official announcement the Cape Cod Canal joining Cape Cod Bay to Buzzard's Bay will be open for general business in November, 1914. The toll rates for the use of the canal will average 10 cents (0s. 5d.) a ton per round trip.

The Westinghouse Marine Steam Turbine

The First of a Series of Articles Describing the Latest System of Turbine Propulsion as Developed by the Westinghouse Machine Company

The advances made by the Westinghouse Machine Company, East Pittsburg, Pa., in the development of the combination impulse and reaction turbine in connection with the Westinghouse floating frame reduction gear point towards a much wider application of the steam turbine to the propulsion of ships than has heretofore been possible.

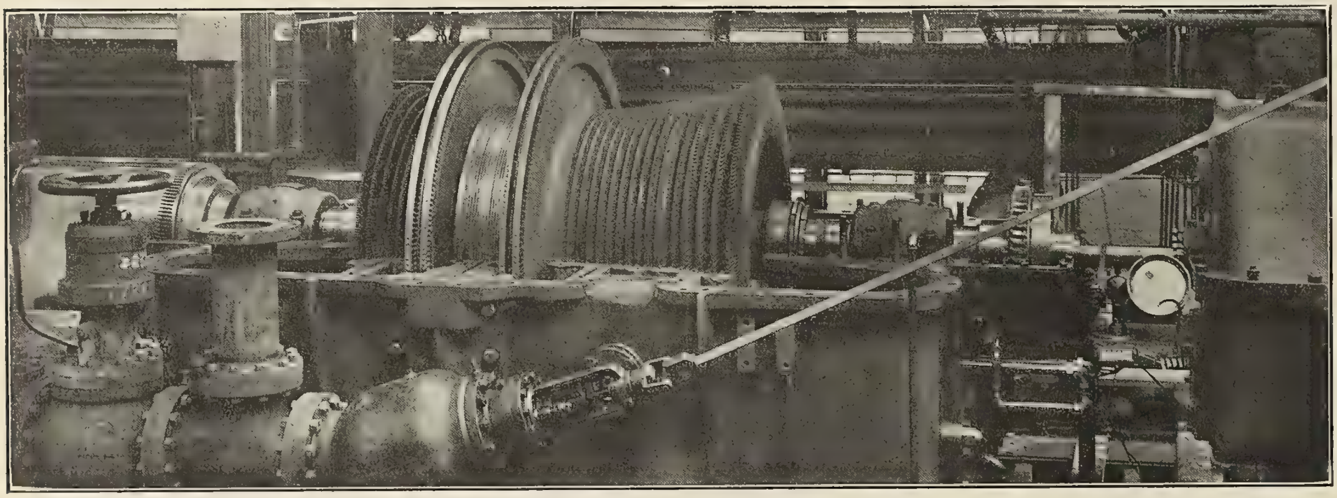


Fig. 1.—General View of Westinghouse Combination Impulse-Reaction Marine Turbine on the Test Stand, Showing Blading

The principal advantages of the reduction gear are generally well known. In the first place, the use of gears permits the turbine to run at almost any desired number of revolutions, and this materially reduces the size and weight of the turbine for any given capacity. At the same time the lower speed of the propeller enables the use of a larger and more efficient propeller, insuring a more economic means of propulsion in ships of comparatively slow speed. Furthermore, with the direct-connected turbine, owing to the increase in weight, and particularly the length of the turbine, it has been difficult to obtain a sufficiently large proportion of the ahead power in the astern turbine, and consequently the maneuvering qualities of the direct turbine-driven ship have not been all that could be desired. With the gear installation, however, owing to the lower speed, the propeller can be made of such ample area that its efficiency when reversing is very much higher than that of a direct-connected one. As a result of this higher propeller efficiency in the geared unit, a smaller proportion of the ahead power gives far better maneuvering qualities than a larger proportion of the ahead power gives in a direct installation.

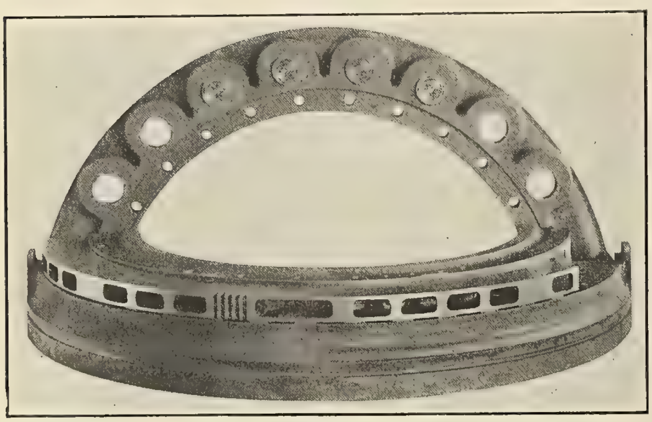


Fig. 2.—Nozzle Block and Sliding Valve, Partly Assembled

With the increased speed of the geared turbine its economy is much higher than that of the direct-connected unit. In a geared turbine installation it is not necessary to develop more than 40 to 45 percent of full power ahead when running astern, since the starting and stopping torque available for bringing the turbine to rest reaches a maximum value of from three to four times the ahead full-power torque. In other words, a turbine capable of developing 40 percent full power ahead actually has a starting and stopping torque greater than the full-load torque ahead.

Most of the disadvantages encountered in a complete reaction turbine are obviated in the design adopted of the Westinghouse Machine Company by the substitution of an impulse wheel for the high-pressure motion of both ahead and astern turbines. The use of the high-pressure impulse wheel instead of reaction blading in marine turbines has two important purposes: First, it has a greater stopping torque, and, second, it permits the use of nozzle control. The use of the impulse wheel, furthermore, materially shortens the ahead and astern turbines, thus making a more compact and lighter installation, and at the same time eliminating the short high-pressure reaction blades so that only a comparatively few rows of large substantial blades are required.

Fig. 3.—Ahead Nozzle Block, Sliding Valve and Balance Pistons Completely Assembled

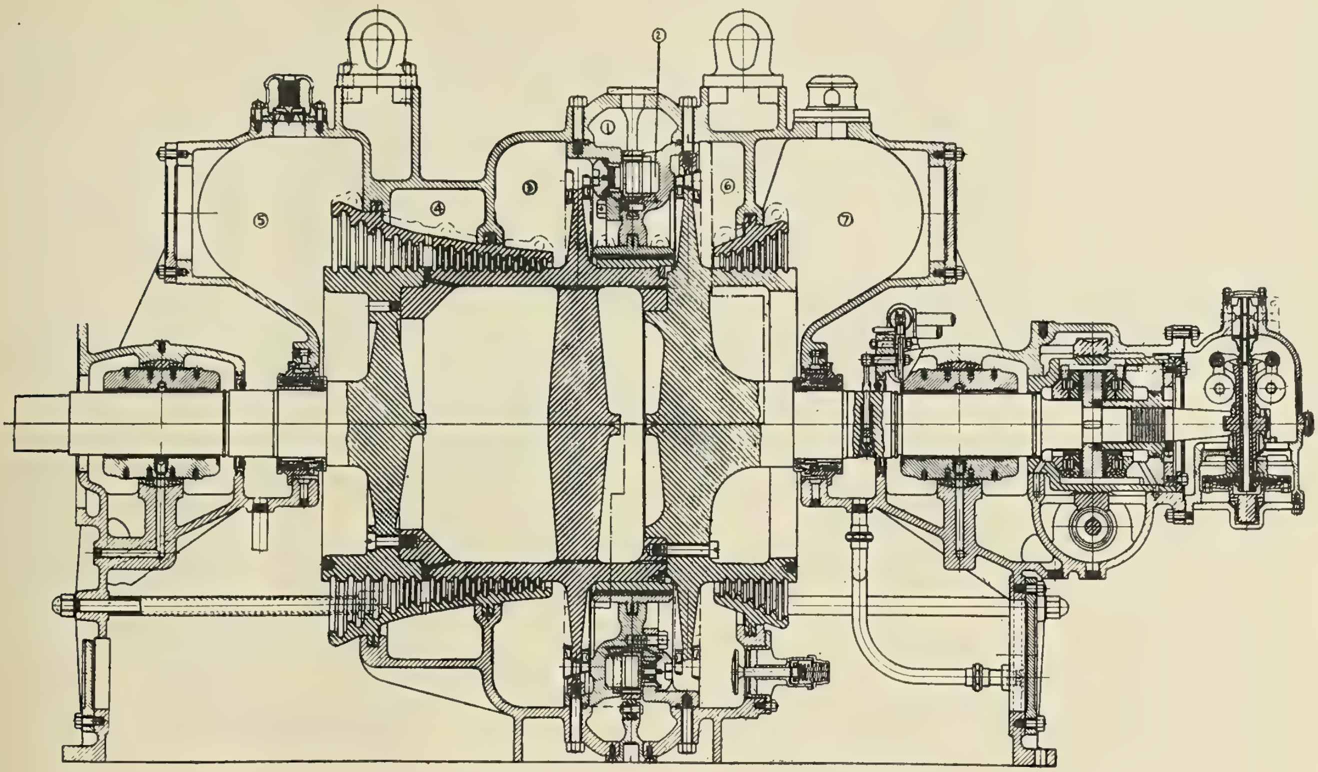


Fig. 4.—Sectional Elevation of Completely Assembled Turbine

The use of the combination impulse-reaction turbine has the further advantage that complete ahead and astern turbines of high economy can be contained in a common cylinder, thus obviating, except under some unusual condition, the necessity of employing the cross-compound arrangement of turbines. Each turbine, where two or more turbines are used to drive a common gear or independent gears, is a complete unit in itself, and may be operated independently of other turbines. In twin or triple-screw vessels each engine room is thus complete in itself without any cross connections and the attending application required to permit operating either high or low-pressure turbines when either one or the other is out of commission.

The combination turbine also has a decided advantage over the pure reaction or pure impulse type of turbine, since it obviates the short, frail blades of the high-pressure section of the pure reaction turbine and also obviates the troublesome diaphragm packings of the pure impulse turbine. Although the impulse wheel is not as efficient as reaction blading, it is nevertheless possible to so design the impulse wheels with two rows of blades that its efficiency will not fall off seriously when the steam velocity is only two and two and

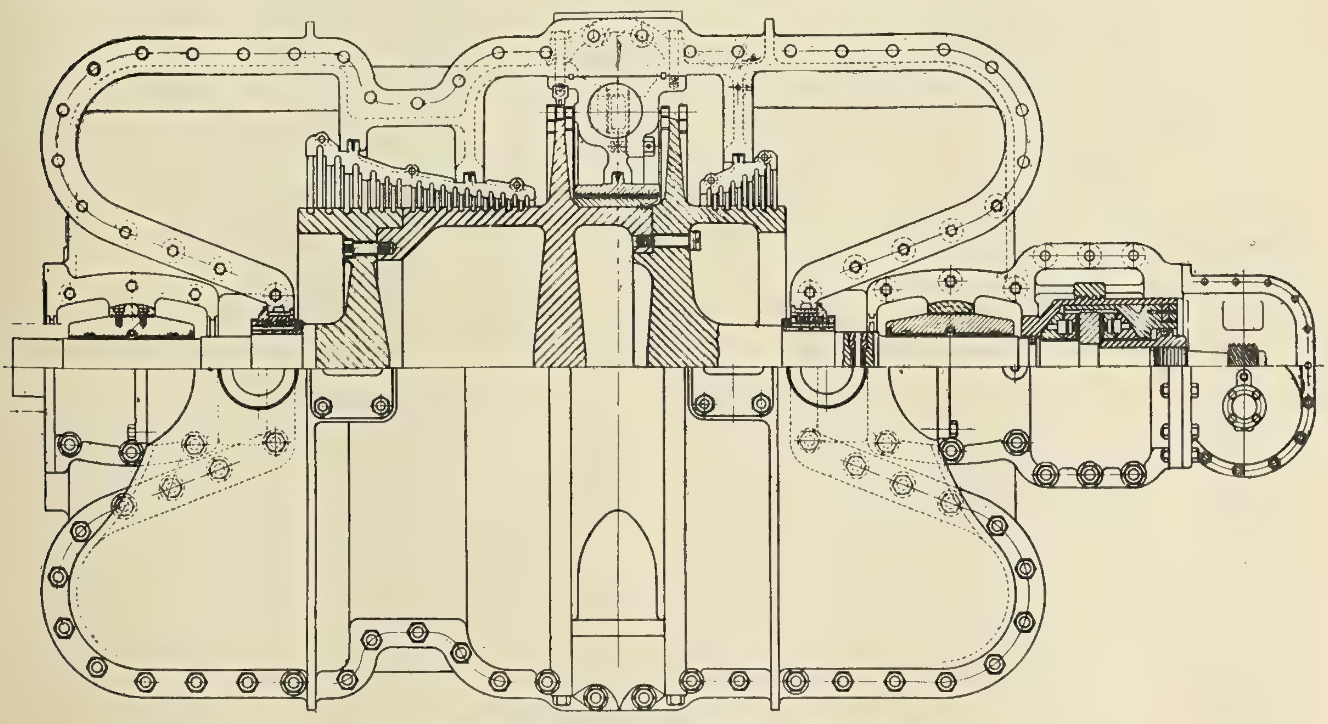


Fig. 5.—Semi-Plan and Longitudinal Section of the Turbine

one-half times the blade speed, and will remain nearly constant until the velocity of the steam reaches four to four and one-half times the blade speed. Thus, by the use of nozzle control, the efficiency of the high-pressure portion of the turbine can be kept nearly constant for a considerable range of power and speed. With the impulse wheel blade space possible in a Westinghouse geared installation, such a large range of heat drop can be efficiently employed that economies only

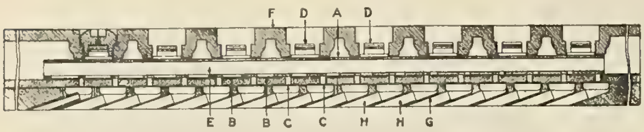


Fig. 6.—Nozzle Valve and Balancing Pistons

approached at full power in the past are possible at cruising speed, and special cruising turbines are entirely unnecessary.

While the following illustrations and description deal only with the Westinghouse marine turbine, subsequent articles will deal directly with the reduction gear, the system of bridge control developed by the Westinghouse Company, and the condensers and auxiliaries which form a part of the complete marine installation.

Fig. 6 is a cross section on the center line of the ahead high-pressure nozzles, showing the nozzle valve and balancing pistons, and Fig. 7 is a partial longitudinal section through

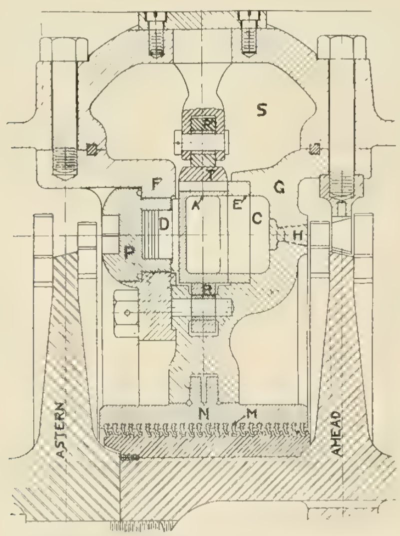


Fig. 7.—Section Through Nozzle Valve and Nozzle

the turbine showing the nozzle valve and nozzles. The valve *A* is made of Monel metal, the valve seat *E* of cast iron, and the balancing pistons *D* and retaining caps *P* are all made of bronze. The nozzle valve proper, *A*, is moved by a rack which engages with gear teeth cut in the periphery *T* of the valve, by means of which it can be partially rotated. To permit the movement of the valve with the least possible force, the valve is supported upon internal and external rollers *R* and *R'*.

The pressure of the steam on the valves is balanced by means of the small pistons *D*, of which there is one for each pair of nozzles, there being twelve nozzles in the ahead and sixteen nozzles in the astern. The space between the balancing pistons *D* and the retaining plugs *P* is connected to the space *C* of the second nozzle in each group of two; thus at any instant the unbalanced steam pressure can be equal only to the area of one of the ports in the valve *E*, admitting steam to the space *C*.

As will be readily seen from the developed cross section of the nozzle valves, the ports *B B* in the valve *A*, and the ports in the valve seat *E*, are so arranged that as the valve is moved to the left, the ports in *E* communicating with the nozzles are opened in succession, thus maintaining the full boiler pressure at the entrance to the nozzles, whether one or all of the nozzles are open.

In order to avoid leakage and distortion, the nozzle valve *A* is of rectangular section, cored out as shown in the developed section, Fig. 6, thus permitting the valve face to make

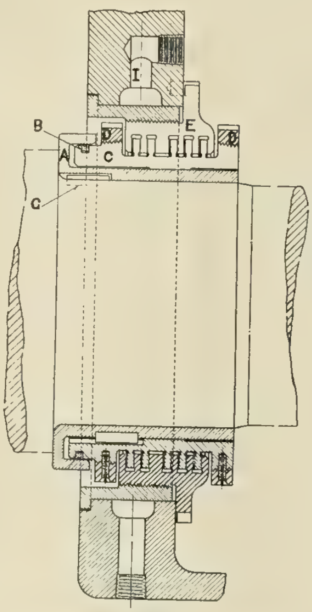


Fig. 8.—Turbine Gland

a steam-tight joint at each port which is not open, while at the same time the box construction ensures the circumferential rigidity necessary.

The main steam supply for the ahead opens into the space *S*, Fig. 7, in the lower half of the turbine cylinder, and steam for the astern opens into a similar space in the upper half of the turbine cylinder. Leakage from the space *S* into the turbine cylinder is prevented by dowel rings as shown.

As will appear later, there is but one dummy in the turbine which divides the high-pressure ahead from the astern turbine. This is shown in detail in Fig. 7. The dummy cylinder ring is a separate casting, which is supported from the nozzle ring *G*. The dummy strips are of the standard type employed in all Westinghouse turbines, and are twenty-four in number.

Fig. 2 shows one of the ahead nozzle blocks and sliding valve partly assembled, and also four of the balance pistons in place. Fig. 3 shows an ahead nozzle block, slide valve and balance pistons completely assembled ready to put in the turbine casing.

A cross sectional elevation of the completely assembled turbine is shown in Fig. 4. It will be noted that the turbine spindle is made in three parts, these being steel castings, one of which forms the forward spindle end and astern impulse wheel and reaction drum. The middle section of the spindle forms the ahead impulse wheel and part of the ahead reaction drum, the remaining part of the reaction drum and after spindle end being formed in a separate piece. The various parts of the spindle are bolted together. This spindle construction is unusually rugged and heavy for marine work, but it is partly necessitated by the comparatively high blade speed of the impulse wheels, which is 525 feet a second at full power. As the effective mean diameter of the ahead and astern reaction sections of the turbine are the same, a single dummy located between the two impulse wheels served for both the ahead and astern reaction sections. However, any slight unbalanced end thrust which may arise in either the

fore or aft direction is amply taken up by a Kingsbury thrust bearing, which is clearly shown in the longitudinal cross section. It will be recalled that the Kingsbury thrust bearing consists of a number of independent babbitted shoes, each supported on a spherical seat formed in a ring, which itself is spherically seated in the bearing housing, thus permitting each shoe to adjust itself independently so as to obtain a uniform bearing pressure over its entire surface, and the spherical seating of the shoe-supporting ring permits the in-

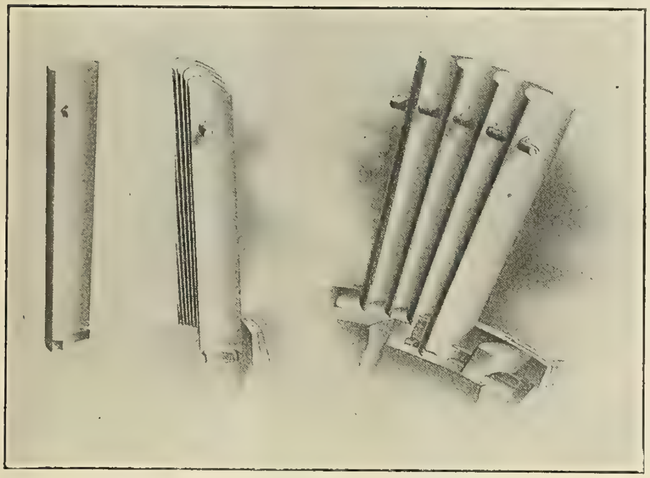


Fig. 9.—Construction of Blading

dividual shoes to distribute the load equally among each other. A single collar on the shaft thus serves in place of the numerous collars used in the older type of thrust adjusting bearing.

The turbine bearings are of the standard Westinghouse spherical seated type, with loose keys and shims, permitting centering the turbine spindle without the necessity of rebabbitting and boring the bearings exactly concentric with the bearing housing.

The turbine glands are a modified type of labyrinth packing, as shown in Fig. 8, consisting of a brass sleeve *A* on the

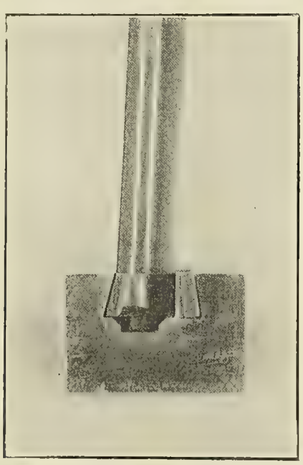


Fig. 10.—Method of Attaching Blade

shaft, in which a snap ring *B* fits and packs the sleeve *C*. The sleeve *C*, which is made in halves, is held together by the rings *DD*, which are screwed on tapered threads. The sleeve *C* fits snugly, but not tight, on the sleeve *A* and rotates with the shaft, but end movement of the sleeve *C*, relative to the shaft, is permitted so that the collars of the sleeve *C*, which fit in the bushing *E* with a few thousandths clearance, will not bind or press too heavily against the bush *E* when the spindle moves endwise from expansion or in taking up the slight end motion of the spindle in the thrust adjustment bearing. A feather key *G*, partly recessed in the sleeve *A* and partly in sleeve *C*, drives the latter with the turbine shaft.

The bushing *E* is screwed into a second bushing, as shown, thus permitting the whole stuffing-box to be removed from the turbine without removing the turbine cover. Steam for sealing and lubricating the labyrinth is supplied through the inlet *I*.

The stationary reaction blades instead of being held in the turbine cylinder proper, as is customary in marine turbines,

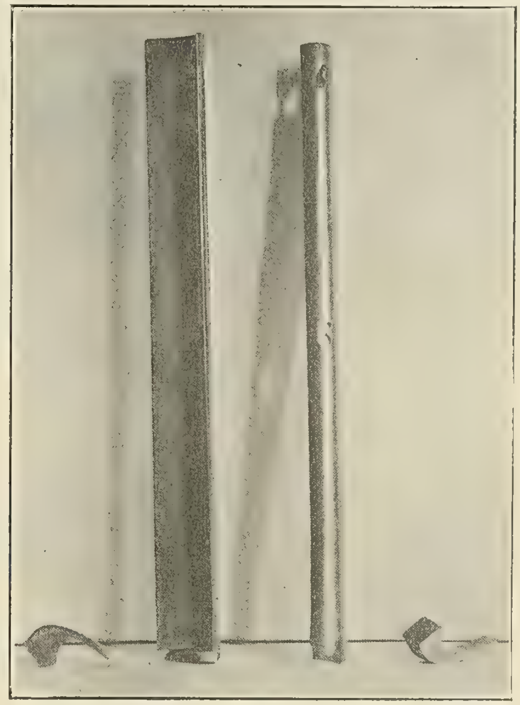


Fig. 11.—Showing Thickening of Ends of Blades

are held in loose cast steel rings, which are doweled in the turbine cylinder so that they can be easily removed. This obviously permits the carrying of spare rings, bladed ready for use, thus facilitating rapid repairs in the event of damage to either the ahead or astern reaction blading. Fig. 1 shows the upper half of the reaction cylinder blade rings removed, exposing the spindle to view.

The auxiliary steam inlet to the ahead reaction blading connects into the space 4, Fig. 4, and through the holes shown in the reaction cylinder blade rings to the low-pressure ahead

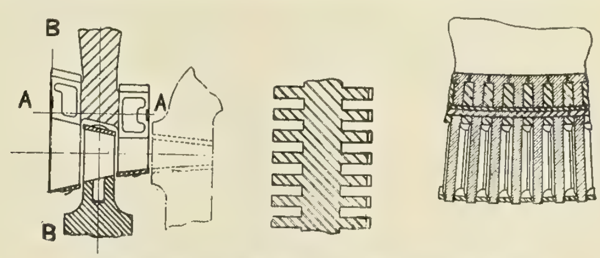


Fig. 12.—Method of Holding the Impulse Blades

blading. The pressure at the point of admission of the auxiliary exhaust is about 16 pounds absolute at full power.

The valve shown, connecting the astern impulse wheel chamber with the condenser, is provided to permit the escape of any steam leaking past the dummy when running ahead without the necessity of its passing through the astern reaction blading, and thus causing additional lost work. This is one of the decided advantages of the impulse wheel when used in this manner, as the steam leaking by the dummy cannot cause any additional resistance in the astern impulse

wheel when the turbine is running ahead. By-passing the reaction blading obviates any loss at this point. This by-passing valve is operated automatically by a piston resisted by the spring, which normally holds the valve in an open position, as shown, but as soon as steam is admitted to the first astern nozzle, the pressure back of the piston brings the valve to its seat.

An automatic stop of the usual type fitted on all Westinghouse turbines, is provided. The automatic stop plunger in the spindle trips a valve which releases the steam pressure under the piston of the automatic stop valve in the main steam line, the automatic stop valve being placed ahead of the control valve so that it serves for both ahead and astern operation.

Fig. 5 is semi-plan view and longitudinal section of the turbine.

Fig. 12 shows the method employed to hold the impulse blades. As will be seen from the illustration, slots are cut in the narrow rim on each side of the impulse disk, and T-headed shanks on the blades are fitted in these slots, the blades thus being literally hung on a cantilever projecting from the impulse wheel disk. A groove is turned in each side of the projecting cantilevers, in which calking pieces are inserted, one of these being dovetail and the other flat. The purpose of these is solely to hold the blades from moving sidewise in the slots. This construction permits making the blade attachment as strong as the cross section of the blade itself, and at the same time reduces the weight of the rim supporting the blades to a minimum and simplifies the distribution of stresses at the rim materially. There is no change from hoop stress to disk stress, as the slots eliminate the tangential stress ordinarily existing in the rim.

In the past few years an entirely new method of blade attachment has been developed by the Westinghouse Machine Company, in which all dependence upon the frictional grip on the blades is eliminated. This new blade attachment is illustrated in Figs. 9, 10 and 11. Fig. 10 is a cross section of a model, which shows the undercut groove and a second smaller groove at the bottom of the primary groove, in which the upset ends of the blades fit.

As will be noted in Fig. 11, the ends of the blades are thickened by upsetting on a gradual taper extending from 1 to 3 or 4 inches from the root of the blade, the actual section of the blade being increased about 50 percent at the root, and at the same time a lip is formed which hooks under the dovetailed shape packing pieces shown. In the smaller blade sections the packing pieces are slipped in by turning them sidewise in the groove until all the blades have been inserted except one or two where the undercut in the turbine cylinder blade ring or spindle is removed to permit inserting the last one or two packing pieces, the space cut out of the dovetail for this purpose being finally filled with a soft calking piece.

In the case of the very largest blades where it is undesirable to remove part of the undercut of the spindle groove, the blades are held in place with double wedges, as shown in Fig. 9. The same form of comma lashing wire, which has been so successfully employed by the Westinghouse Machine Company, has been retained in marine turbines.

The upsetting of the ends of the blades and tapering of the normal section towards the tip of the blades, very materially increases the resistance of the blades to bending stresses, and also to those very serious stresses arising from vibration, and whereas in all other forms of reaction blading attachments the weakest section of the blade is where it meets the cylinder or spindle, this is the strongest point of the blade in the Westinghouse design. This is very clearly shown by the fact that when the lip, Fig. 11, is gripped in a vise and the end of the blade subjected to a bending pressure, the first indication of any bending whatever occurs some 2 to 3 inches from the lip in long blades, and, of course, at a somewhat shorter distance from the lip in very small blades. The result of this method of blading is that even most serious rubs between the blades and stationary portion may be encountered without any damage to the blades other than burring of the ends.

In order to permit the gear pinion to float longitudinally without imposing any end thrust on the teeth of the pinion or gear, a special flexible coupling was designed by Mr. Westinghouse. The coupling consists simply of two flanged collars, one on the turbine and one on the pinion drive shaft, and a ring bolted to the portion of the coupling on the turbine shaft. There is a slight clearance between the ring and the hub, and the driving force is transmitted through the ring to the hub by means of steel balls, which are inserted in holes drilled partly in the ring and partly in the hub. These holes are lined with hardened steel bushings made in halves, and the balls are retained from coming out of the hole by means of a retaining ring. This coupling is extremely simple and facilitates taking the turbine spindle or pinion out without disturbing any other part. After extended service it has proven itself entirely satisfactory for this work.

The New Hamburg-American Liner Vaterland

The *Vaterland*, of the Hamburg-American Line, which arrived in New York May 21 on her maiden voyage, is the largest steamship in the world. While closely resembling her famous sister ship, the *Imperator*, in construction and equipment, the *Vaterland* is of greater dimensions and presents many original features. The vessel measures 927½ feet in length over all, 100 feet in beam and has a gross tonnage of 53,500. On her trial trip the *Vaterland* is reported to have developed a speed of 26.3 knots.

The construction of the *Vaterland* was commenced in September, 1911, in the yards of Blohm & Voss, at Hamburg, and the vessel was launched April 3, 1913. She conforms in every detail of her construction and equipment to the latest rulings of the German, English and American laws governing shipbuilding. She is constructed with a double bottom and a double skin extending well above the waterline. Her hull is divided by steel bulkheads, both longtudinal and transverse, and contains five steel decks, which with four superimposed decks gives her nine decks above the waterline. Increased stability is obtained by the installation of Frahm anti-rolling tanks.

An entirely new arrangement of the public rooms has been made possible by the unusual position of the funnels of the *Vaterland*. The funnels pass through the decks at a point near the sides of the hull instead of through the center of the ship. By removing this obstruction it has been possible to have one great saloon open directly into another, thus giving the ship a remarkable effect of artistic spaciousness. This vista extends from the Ritz-Carlton restaurant through the winter or palm garden and the grand hallways, to the main lounge or ball room. The grand staircase, which is one of the most attractive features of the *Vaterland*, extends through six decks. The several staircases are supplemented by three passenger elevators in the first, and one in the second cabin, running through six decks.

The *Vaterland* is manned by a crew of 1,234 men. She is commanded by a commodore, four captains and seven officers. There is a chief engineer, three first engineers and thirty-five assistants and electricians. The boilers are operated by twelve chief firemen, fifteen oilers, 187 stokers and 189 trimmers.

In no other ship probably is electricity so generally employed. About 15,000 electric lights are installed, and the elevators, both passenger and freight, the hoists, derrick operating machinery, the kitchens, are all operated electrically. The cabins and staterooms of the first cabin are heated by

Fig. 1.—The Hamburg-American Liner *Vaterland* of Over 53,000 Gross Tons

electricity, and an abundance of fresh air is forced to every part of the ship by an electric ventilating system.

The main lounge of the *Vaterland,* the largest and most sumptuous of the public rooms, is provided with a concert stage and a dancing floor. The smoking room, located forward, directly beneath the bridge, is open on three sides, thus affording an uninterrupted view of the sea and assuring perfect light and ventilation. The main dining room seats upwards of 800 guests. The Ritz-Carlton restaurant is oval in form, exactly reproducing the restaurant under the same management in New York. A special feature has been made of the palm garden, which is decorated with a wealth of tropical foliage. The ladies' writing rooms, library and lounges are especially large and attractive.

The sumptuous Roman bath, which has proved such a popular feature on the *Imperator,* has its counterpart on the *Vaterland.* The swimming pool measures 20 by 40 feet, and has a depth of 10 feet, and grouped about the pool are a variety of therapeutic baths.

Propulsion is by four great screws, each 19 feet 7 inches diameter, driven by turbine engines. At full speed the propellers turn at about 150 revolutions per minute. Two high-pressure and two low-pressure astern turbines are provided. Steam is supplied by forty-six watertube boilers, arranged with four stokeholds. As a special precaution the forward engine room is divided into three watertight compartments, and the aft room into two compartments.

The *Vaterland* has accommodations for over 4,000 passengers. Her lifeboat equipment includes eighty-three lifeboats accommodating about 5,300 persons. Two of these are

Fig. 2.—View of the Grand Saloon on the *Vaterland*

motor boats carrying special wireless apparatus. The lifeboats are handled by Welin quadrant davits, with a complete equipment of lowering and hoisting appliances.

The wireless telegraph equipment of the *Vaterland* is the most powerful ever installed on shipboard. It comprises three separate sending instruments and includes six antennae. The special long-distance service equipment will keep the vessel continuously in touch with land throughout the Atlantic crossing. A second system will operate over 400 miles a day and 1,200 miles at night, while a third emergency outfit, operated by storage batteries, is kept in reserve. The wireless station is in charge of three operators, one of whom is constantly on duty.

The Rational Non=Diesel Marine Oil Engine*

BY ALBERT H. ZIEGLER

From the points brought out in the first instalment of this article it is evident that a successful oil engine must be designed and constructed to burn oils considerably heavier than kerosene (paraffin). This, in all probability, the carburetor type will never do.

Kindred to the exhaust-heated carburetor there is a type of so-called oil converter, which consists of a large muffler-size, double-wall, cast iron, exhaust-heated chamber, comprising a generator valve or a simple form of carburetor for the admission of the spray oil, and also a "butterfly" or other type of valve, which by-passes some of the engine exhaust gases through the converter as a means of heat regulation, according to the position of a throttle. The contrivance is really nothing more than an immense oil carburetor with a great expanse of exhaust-heated surface, from which the kerosene (paraffin) is vaporized by coming in direct contact with it. The effectiveness of this device is even less than that of the oil carburetor, as it is subject to all the same defects, only in an accentuated form. The oil is more liable to "cracking," and as the charges enter the cylinder at extremely high temperatures, and very much expanded, less power is developed for a given size of cylinder.

Another type of exhaust-heated, double-walled converter contains within the oil-gasifying chamber either a concentric series of cylinders of specially prepared fireclay and graphite with annular air spaces between their surfaces, or else the chamber is filled with balls of the same material. This gasifying chamber is surrounded by an exhaust chamber, and this in turn is covered with asbestos or other heat-insulating material. A generator valve or a simple oil carbureting device divides and sprays the fuel into this gasifying chamber directly upon the fireclay and graphite. Before starting the engine a small cover on one end of the gasifying chamber, and also a vent from the opposite end, are opened, and a blow-torch is directed against the clay until the clay becomes red-hot. The cover and the vent are then closed, and the engine is operated on gasolene (petrol) through a special carburetor on the engine inlet pipe. Meanwhile the oil is allowed to spread into the convertor, and when gas appears the gasoline (petrol) is shut off and the engine is run on oil-gas.

The oil generator valve on the converter, actuated by the cylinder inspirations, admits oil and a small quantity of air to the gasifying chamber. The oil is sprayed out over the red-hot clay, the small quantity of air present supplying only sufficient oxygen to burn a very small part of the oil admitted in order to keep the clay at a bright red heat. The balance of the oil is virtually roasted into a more or less fixed gas, and the carbon dioxide formed by the combustion of the heating oil combines with sufficient gasified carbon to convert it into carbon monoxide, and the whole combustible gas is piped to an air and gas mixing valve on the engine inlet pipe. Though the oil is undoubtedly "split" in contact with the red-hot clay surfaces, the heavier carbons adhering to them are gradually turned into a gaseous condition, and any incombustible components of the oil are carried away in the current of gas as very fine dust, which remains suspended, passes through the engine and out the exhaust.

In spite of the high degree of heat applied the gas produced is mainly an unfixed gas. Even though it is carried to the engine cylinders mixed with air at a temperature of about 400 degrees F., a certain amount of the heavier condensations forms on the upper walls of the inlet passages and pass into the engine cylinder in liquid form, causing gradual carbonization and fouling. Moreover, the highly heated and expanded cylinder charges materially reduce the power output for a definite cylinder size. The carbon dioxide and a small quantity of carbon monoxide, however, act as deterrents to premature and self-ignition, so that the engine compressions attained compare favorably with those of the gasoline (petrol) engines.

With this form of converter can be used the heavier kerosenes (paraffins), solar oil and gas oil with fair results, the consumption being in the neighborhood of .8 pound per brake horsepower-hour. The engine is reasonably flexible automatically from full load down to about 30 percent load, after which on continuous operation the heat in the converter drops to a point where either an external application of the blow-lamp becomes necessary, or the engine must be operated on gasoline (petrol).

Having found unfixed gas generators an unsatisfactory means of using oil fuels, many American manufacturers have attempted to use the out-and-out oil gas producer, in which the oil gas is passed through a comparatively vast bulk of white hot material in order to render such gases non-condensible. One such device consisted of an ordinary anthracite gas producer of small size in the center of the coal bed on which the oil fuel was sprayed, gasified and fixed in its passage through the bed to the outlet. All air for supporting combustion in the producer was admitted with the oil which it sprayed. The gas produced was then passed through scrubbers and to the engine, as in other gas producer installations.

Another type of oil gas producer consisted of a long, horizontally-arranged steel shell, lined with either asbestos or fireclay to a depth of several inches, more than half of the interior being filled with checker brick work or an extremely porous fireclay construction. A small opening in the vacant end of the chamber admitted an oil spray nozzle, through which the fuel was atomized into the chamber by means of either steam or compressed air. On being ignited, the flame from this atomizing nozzle rapidly heated up the entire interior to a dazzling white heat. The flame was then extinguished and the excess of air cut off, only enough air being admitted thereafter to maintain the proper degree of heat within the producer with a steady flameless, practically spontaneous combustion. The gases thus formed were taken out through the end of the producer opposite the sprayer, while an economizer heating the incoming air and oil surrounded the hot gas outlet pipe. The subsequent handling and application of the resulting fixed gases were as in the coal-fired producer.

These producers can be operated on any oil that can be made to flow through the atomizer. As the gases are passed to the engine in a cold, clean and non-condensible condition, the engine can be operated on a cold and unexpanded incoming charge with compressions of from 80 to 90 pounds, giving a power output not less than in a gasoline (petrol) engine. The oil consumption, however, is rather high, due principally to producer radiation and gas cooling. Also on account of the

* Continued from the May number.

absence of extremely large gas holders, the automatic control of the oil feed and the maintenance of the proper interior temperature under varying loads becomes necessary, but this as yet has not been successfully accomplished. Moreover, the great bulk, weight, first cost, cost of operation and repair and sacrifice of valuable room on board ship, which any such fixed oil gas producers would involve, make such installations inapplicable to most classes of deep sea-going vessels.

By far the greatest amount of experimenting and research carried on by American marine oil engine builders has been along the lines of the hot bulb compression-chamber type. In this type the bulb is heated by a blow-torch for starting the engine, and the oil fuel is sprayed or more or less atomized into this hot bulb at the beginning of the suction stroke. Gasification of the oil is accomplished by the heat of the bulb aided by the heat of compresson, and this gas pours out of the bulb into the separately admitted air charge, the gas and air being mixed by whatever eddy currents may exist in the air charge during the suction and compression strokes. Ignition by electric spark is seldom resorted to, as the bulb acts as a tube igniter to all intents and purposes.

In such engines the cylinder clearance volume, or compression space, is practically all contained within the hot bulb, the engine inlet and exhaust valves opening into the cylinder proper at one side of the neck of the bulb. Thus the fresh air charges are taken into the cylinder cold and unexpanded, while the heat of the bulb is not greatly lowered or dissipated through the incoming charges, as these enter the bulb only upon being compressed, and therefore materially heated. Considerable combustion of the charge occurs in a non-water-jacketed chamber, conserving much heat that would otherwise be lost, while the heat of combustion serves to keep the bulb at a proper heat.

The oil sprayed into the red-hot bulb is, of course, "cracked," but the heavier carbon components adhering to the heated walls are all virtually roasted out into gas. The gases formed in the bulb, though by no means fixed, are not subjected to recondensation, as they do not have to pass through long, tortuous, cool passages.

The difficulties and shortcomings of the hot-bulb engine are due principally to the fact that with practically pure air against the piston and gas entirely unmixed with air at the opposite end of the bulb, there is only one point somewhere between these extremes where the gas and air are mixed in the proper proportions for complete combustion. This results in a somewhat smoky exhaust and a considerably lower mean effective pressure, and therefore a lower power output than would have been possible had the engine contained a charge of uniform non-stratified homogeneous gas and air mixture. The incompletely burned rich mixture end of the charge causes a slow sooting and gumming up of the combustion space, piston rings and valves. The low power output for a definite size cylinder is accompanied with a high fuel consumption, resulting in very incomplete combustion of much of the gas formed in the bulb. Though at full load the bulb temperature remains at an efficient gasifying and igniting point, as the load is decreased the temperature rapidly drops and serious difficulties arise, preventing further operation unless the blow-torch be put into service, or an electric ignition system applied, or both. These conditions may perhaps be permissible in a single-cylinder stationary engine, but they are inadvisable in a multi-cylinder marine engine.

Without proper provisions for the introduction of either water or water vapor into the cylinder of any engine compressing an intimately intermixed charge of air and oil fuel before ignition takes place, the degree of compression possible is ordinarily limited by the proneness to pre- and self-ignition, depending upon several functions.

The degree of compression attainable is dependent not only upon the ignition temperature of the charge before compression, the temperature of the in-take valves, passages, piston top, combustion space walls, the presence of small overheated parts, such as igniter electrodes, the sharp corners, fins and projections into the combustion space from the cylinder, cylinder head and piston, but also upon the chemical composition of the fuel used. All fuel oils contain not only considerable hydrogen (a gas easily set off by high compression), but also certain olefiant and marsh gases, having a tendency similar to that of acetylene to become easily ignited upon the application of heat and compression. Without the application of water in proper quantities and correctly delivered to the charge, non-Diesel oil engines would be limited to extremely low compression pressures, lower by far than is common with the gasoline (petrol) engine, whereas the proper use of water in such oil engines makes possible compressions far in excess of those found in gasoline (petrol) engine practice. German investigators have proved by actual experiments that with the proper use of water compressions approaching that of the Diesel engine caused no self or premature ignitions, and also that, due to such high compressions, the thermal efficiency of such non-Diesel engines was practically equal to that of the Diesel engines.

When water is atomized into the cylinder charge, it is, upon combustion of the fuel charge, dissociated into its component parts—oxygen and hydrogen. The process of dissociation absorbs much of the heat of combustion, thus considerably reducing both the maximum temperature and the maximum pressure of explosion and relieving the mechanical parts of the engine from excessive stress. Further down the stroke the oxygen and hydrogen recombine, setting free the heat absorbed from the burning charge at the upper dead center, thus increasing the temperature, and therefore the pressure, of the gases within the cylinder at a part of the stroke where the resulting pressure on the crank is more effectively delivered to the shaft in turning moment. The mean effective pressure is materially increased, the shock of explosion lessened, and a much smoother running engine produced. Also, due to the higher compression made possible, the thermal efficiency is greatly increased through the use of atomized water in the cylinder.

In summing up the above facts, it becomes evident that the American manufacturers may have very definite hopes for a practical and efficient non-Diesel type of the heavy oil engine, involving no greater weight, bulk, complication, cost of production, cost of operation, upkeep and repair, cost of experimenting and no extremely high-pressure equipment, and no greater skill or knowledge on the part of the operating engineer than is involved in the present large-size gasoline (petrol) marine engines. Such engines would burn as heavy and as cheap oils as any Diesel engine could handle, and the fuel consumption per brake horsepower-hour would be practically the same as in the Diesel engine.

(To be concluded.)

Reconstruction of the S. S. Glenroy.—The steamship *Glenroy*, owned by the Royal Mail Steam Packet Line, which was extensively damaged by fire at Portland, Ore., in March, has been completely rebuilt at the yards of the Seattle Construction & Dry Dock Company, Seattle, Wash. The contract for the repairs was one of the largest handled on the Puget Sound in recent years and included taking off seventy-one plates, which were faired and returned; the removal and replacement of 23,000 rivets; the renewal of all joiner work in the vessel; the laying of a new teak deck; and the renewal of the bridge house, flying bridge, captain's quarters, chart room, poop deckhouse, and the port side of the fidley. The work was completed well within the contract time of thirty-one days.

The Watertight Subdivision of Ships and the Effect of Bilging—II

BY A. L AYRE

Watertight longitudinal bulkheads cannot be recommended for subdivision purposes generally, owing to the dangerous resultant effect on a vessel's transverse statical stability when one side only is bilged. A good deal is to be said in favor of their adoption in the case of dividing twin engine rooms, when in the event of one side being damaged the vessel still has some means of propulsion retained intact on the opposite side; but, even in such a case, a serious list may occur which might greatly impede, and perhaps prevent, the work of launching boats, and, further, in the case of a vessel with a fairly long compartment longitudinally divided on the center line, or a vessel without a large amount of righting arm of stability, it is quite conceivable that she would capsize as a result of the bilging of one side only.

The following example shows the effect of bilging one side of a 'midship compartment which has been divided by a longitudinal watertight bulkhead fitted on the center line in the case of a vessel 500 feet long by 60 feet beam by 26 feet draft, the block coefficient being .63, giving a total load displacement of 14,130 tons. The length of the bilged compartment is 100 feet.

Assuming the compartment to be empty of cargo, the lost buoyancy (one side only) is:

$$\frac{100 \times 30 \times 26}{35} \times .92 \text{ (coefficient of this portion)} = 2{,}050 \text{ tons.}$$

The center of gravity of this lost buoyancy is 14.72 feet from the center line.

The area of the load-water plane is $500 \times 60 \times .73 =$ 21,900 square feet, and the area of the *lost* portion of waterplane in way of the damaged compartment is $100 \times 30 =$ 3,000 square feet. The net area of intact waterplane is therefore $21{,}900 - 3{,}000 = 18{,}900$ square feet. The center of gravity of the lost area is 15 feet out from the center line, and on account of the removal of the waterplane area in way of the damaged compartment at this position, on the port side, say, the center of gravity of the new waterplane will have moved out to starboard to a position which is found as follows:

$$\frac{3{,}000 \times 15}{21{,}900 - 3{,}000} = 2.38 \text{ feet,}$$

this being the situation of the center of gravity of the new waterplane measured out to starboard from the center line.

This position will also represent the point above which the center of gravity of the added layer of buoyancy will be placed, and it is therefore seen that 2,050 tons of buoyancy is lost at a point 14.72 feet out on the port side and the same amount added at a point 2.38 feet out on the starboard side. This will give a moment of transference equal to $2{,}050 \times (14.72 + 2.38) = 35{,}055$ foot-tons, which also represents an upsetting moment of statical stability, and this divided by the total amount of displacement will give the new position of a center of buoyancy in the upright condition, and measured out from the center line towards the starboard side, $31{,}655 \div 14{,}130 = 2.24$ feet, which is the value of an upsetting lever of stability in the perpendicular condition of the vessel. In Fig. 3 the direction of the forces of gravity and buoyancy are shown for this condition, and according to the direction and relation of these forces it is seen that the vessel will incline to port. Another position may eventually be reached, as shown by Fig. 4, from which it is seen that the forces are still acting with a capsizing tendency. It will be noticed that the center of buoyancy has traveled in a port direction, owing to the inclination of the vessel, but that it has not traveled fast enough to overtake the line of force which acts downwards through the center of gravity.

Should it have happened that the center of buoyancy had moved out to port more rapidly during the inclination, so that it had reached a point vertically in line with the force of gravity, a position of rest, or angle of steady heel, would have been reached, as shown in Fig. 5; but in a case similar to the one under consideration, it is extremely doubtful if such a

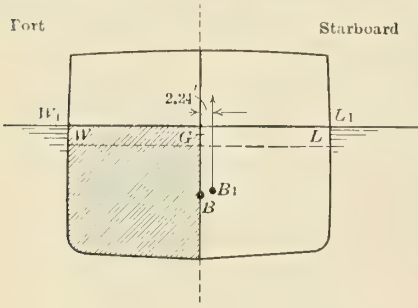


Fig. 3

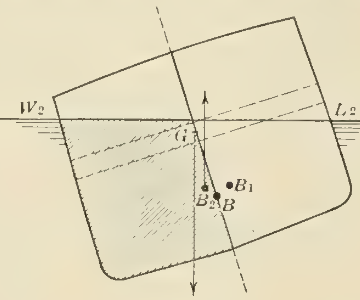


Fig. 4

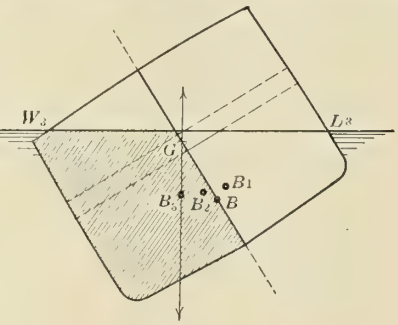


Fig. 5

condition as this could be attained, and the most likely result is that the vessel will capsize.

In such circumstances, a vessel having a large amount of freeboard and initial statical stability would have the best chances of not capsizing, and should she have a watertight lower deck, which would arrest the amount of bilging in a vertical direction, and thereby enable the buoyancy in the topsides of the damaged compartment to be preserved, her chances would again be better still, as this would further assist the travel of the center of buoyancy to port during the inclination.

A representation of the relation of the upsetting lever to the curve of righting levers is given in Fig. 6, on the assumption that the center of buoyancy is traveling to port at the same rate as the variation in righting arm ($G\ Z$); but it should be remembered that on account of the loss of buoyancy in the topsides of the damaged compartment this could not always be expected. In any case it is seen that the net amount of upsetting lever, which will be the difference between the varying righting levers and the upsetting lever, is decreasing, but that in this case the righting levers—or the port travel of the center of buoyancy—does not reach an amount sufficient to overcome the amount of 2.48 feet of upsetting lever, and the vessel consequently capsizes. The curve of righting levers shown is one corresponding to the waterline $W_1\ L_1$ in Fig. 3.

As none of the figures used in this example is by any means exaggerated the very great danger of longitudinal center line bulkheads is seen, and they should therefore not be recommended for use in the case of large passenger ships.

We may now proceed to consider the principal ways in which flooding may result from damage in various forms, the resultant effect of same and the methods of subdivision suitable for making provision against foundering.

First. The vessel running bow on in collision with another

vessel or iceberg, etc. Should the vessel be runing at a high speed there will usually be extensive bow damage and flooding of the forepeak compartment. The safety of the vessel may not, however, be endangered, provided the shell damage has not extended aft of the collision bulkhead, that the collision bulkhead has not been damaged, and that the bulkhead is capable of withstanding any extra strain that may be brought upon it owing to the flooding of the forepeak compartment.

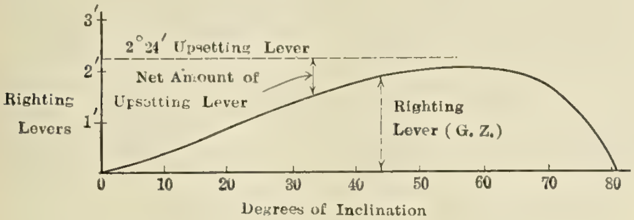


Fig. 6

In cases of severe impact it frequently happens that one of the foregoing provisions does not obtain, and the consequent flooding of No. 1 hold compartment takes place; while it is not unlikely, in cases where the collision flattens the bows back to the collision bulkhead, that the impact will be here imparted to longitudinal deck girders and by these transmitted to the next transverse bulkhead, so that straining may take place to the extent of destroying the watertight efficiency of same. In vessels without longitudinal girders beneath the decks it is not likely that the shock would be transmitted in this way, and the tendency is for the decks to spring or buckle, though its occurrence is quite probable in the case of heavy and rigid girders.

Should the second bulkhead be injured in this way it is, of course, obvious that after No. 1 hold has filled flooding of No. 2 hold will take place. It may also happen that the second bulkhead, *i. e.*, at the after end to No. 1 hold, will give way under the pressure of the water.

The buoyancy of the extreme fore end of the vessel for a length of 30 to 40 percent of the total length of ship may be lost as the result of such a collision, and a most serious change in trim would occur, which, even if it were possible for the vessel to remain afloat, would almost certainly, in average cases, render her unnavigable and unseaworthy.

So in order to guard as far as possible against total loss in such cases further subdivision than that provided by the transverse bulkheads is desirous. Longitudinal center line bulkheads are not suitable for the reasons previously mentioned, and it remains, therefore, to adopt the watertight lower deck as a means of minimizing the amount of flooding by limiting same in a vertical direction. Any heavy longitudinal girders fitted to this deck would be best stopped short of the collision bulkhead, and other compensating means of strengthening provided, and the risk of the impact being transmitted any further aft being thereby lessened.

Secondly. By the side shell plating being rammed between two transverse bulkheads by another vessel. In this case the flooding is not so serious as in the previous instance, so long as the loss of buoyancy is confined between two bulkheads, but the great necessity of these bulkheads being able to withstand the very great pressure is apparent.

Thirdly. One of the bows of the vessel coming in contact with submerged ice or wreckage, etc., in such a manner as to strip off or damage the shell plating over a large length of the vessel's side and thereby expose to the sea a large number of compartments. Fig. 7 shows a vessel damaged under such circumstances. It will be seen that four compartments are exposed to the sea as a result of the collision, and the buoyancy contained in about 45 percent of the vessel's length thereby lost.

This is probably the worst possible means of bilging, and while it may be rare in occurrence it is yet essential that some provision be made in the design so as to minimize the risk of subsequent foundering. In such a case the transverse bulkheads within the limits of the damage (excluding the endmost ones) play no part whatever in arresting the flooding, and without any additional means of subdivision the vessel must certainly founder. Such a vessel fitted with longitudinal bulkheads, which, while limiting the amount of lost buoyancy to one-half, would put the vessel in a much worse plight, would positively founder after capsizing owing to the resultant effect on the statical stability, as was seen in a previous example. There would, in fact, be much better chances of launching boats and saving life in the case of a vessel without the longitudinal bulkheads sinking by the head than in the case of the rapid transverse inclination and capsizing of the vessel if same were fitted.

It seems, therefore, that we must revert to the watertight lower deck, by means of which the flooding would be limited in a vertical direction, without having the disastrous effect on stability as occurs by limiting the amount in a horizontal direction.

Fourthly. The vessel grounding and receiving bottom damage either locally or over a large part of her length. This form of damage is, as a rule, of a most serious nature when resulting from grounding on a rocky bottom while running at a high speed. In such cases the great value of the cellular double bottom is usually found, but occasionally the inner bottom is also pierced or its watertightness impaired by straining.

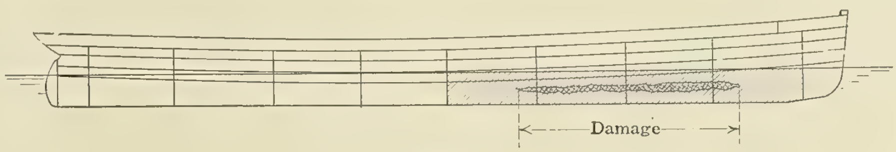


Fig. 7

Should the damage be local the effect of the flooding on the reserve buoyancy will be similar to that of the collision damage between two transverse bulkheads, as mentioned in the second case above; but should it extend beyond one compartment—which is a very probable case—it is obvious that some further means of subdivision are desirable if the chances of floating the vessel are not to be endangered. In this case longitudinal center line bulkheads are of still less practical value owing to the great likelihood of the bottom damage occurring on both sides of the center line. It is again seen that the most effective way in which to restrict the flooding will be to do so vertically, and this by means of the watertight lower deck.

A further effect to consider is that of strain resulting in either of the above cases owing to the impact and to the subsequent flooding and loss of buoyancy. The strain effect may be put under three heads, as follows:

1. Accruing from impact.

2. Pressure of water against bulkhead which is unsupported on opposite side.

3. The loss of buoyancy and the insufficient support remaining for the weight contained within the space.

The first may cause the gradual bilging of another compartment owing to the calking and riveting being "started,"

so as to render inefficient the watertightness of other vital portions of the structure.

The second may have results similar to those of the first, with the further danger of the bulkhead giving way at any moment and the consequent rapid flooding of the adjacent compartment.

The third may be the means of severe general structural stresses being set up, having the same strain results as in the case of the first. These stresses may even reach such a magnitude as to cause the breaking of the vessel into two parts, as the result of the redistribution of buoyancy following on the bilging.

(To be continued)

The Design of Boats for the New York State Barge Canal

A problem which deserves much more attention on the part of vessel owners, naval architects and shipbuilders than it has yet received is the design of suitable boats for operation on the New York State Barge Canal. The canal will be opened for transportation within the next year or so, and it is estimated that millions of tons of grain, coal, iron ore and other raw material will pass through the canal each year.

The length of the canal from the Niagara River terminal to the Hudson River is 323 miles. In addition to the main canal there will be several branches to Lake Champlain, Lake Ontario, Cayuga Lake, Oneida Lake, etc. While the greater part of the traffic through the canal will consist of bulk cargoes, such as coal, ore, grain, etc.; it is believed, however, that lines for fast freight or package service will be encouraged, and this service will call for more or less traffic throughout various parts of the canal. The nature of the traffic, therefore, seems to call for two types of boats, one of the largest possible capacity for through-bulk freight, and the other of smaller dimensions for local package freight.

In order to develop the best type of boat for the canal service, International Marine Engineering offers to publish designs or suggestions from its readers which will aid in establishing the best form of hull for such service, the most efficient system of propulsion and also the most economical methods of loading and unloading the vessels. As, of course, the most suitable design of boat for this service depends upon the physical characteristics of the canal, its locks and the port facilities, the following points should be borne in mind:

In the thirty-five main canal locks, in which the distance between gates is 338 feet, the maximum space for locking purposes is 310 feet in length, 45 feet breadth and 12 feet depth of water over the sills. This, generally speaking, is sufficient to accommodate a 3,000-ton barge. The depth of water in the canal prism will also be 12 feet. At several points in the canal, where there are 4-degree curves and a 75-foot channel, two boats 300 feet long and 22 feet beam could pass with a space of 8½ feet between them. Boats of the maximum dimensions corresponding to the locking capacity could pass through any portion of the canal, but, in the restricted portions, one boat could not pass another.

It is understood that the use of so-called paddle-wheel boats will not be permitted, but otherwise no definite regulations have as yet been made. Speed limits will be about six miles per hour in the narrow parts of the canal, although considerable more speed will be permitted in the lake and river sections, probably up to 12 miles an hour. Besides the tonnage and speed limits, head room is limited to a maximum of 15 feet 6 inches, owing to low bridges or other overhead obstructions. Under the present law, the season of navigation in the canals of the State begins May 15 and ends November 15. It is not probable that this law will be changed materially.

It is believed that eventually two types of boats will be adopted, one that will have sufficient strength of construction and enough freeboard to adapt them to the roughest service on the Great Lakes as well as outside of New York harbor, and that these boats will have the maximum capacity permissible and will be operated by their own power. Whether these boats will tow barges of the maximum size, or of smaller size, remains to be seen. The second type of boat will be of smaller dimensions and designed exclusively for use in the canal and its branches and adjoining rivers.

The report of the Barge Canal Terminal Commission states that the average cost of railroad haulage of freight per ton between Buffalo and New York is $1.96 (8s. 2d.), while the engineers of the Commission estimate that the cost of carrying a ton in efficient boats by the canal will be only 26 cents (1s. 1d.) As to the actual tonnage of freight that will pass through the canal no definite estimate can be made. At the time the canal was planned an estimated tonnage of 10,000,000 was borne in mind, but the water supply is sufficient for twice this tonnage.

In view of the fact that facilities for cheap transportation over such an important thoroughfare will soon be available, naval architects and shipbuilders should take this problem in hand at once and bring out designs or suggestions which will aid in determining the most suitable type of boat for this service.

Shipping of the Port of London.—The annual report of the Port of London Authority for the year ended March 31, 1913, shows an increase in the value of the trade of the port, but a decrease in the tonnage in consequence of the coal strike in March and April of 1912, and of the general strike at the port during the months of May, June and July. There was a net decrease of 986,849 tons as compared with the previous year. The tonnage of vessels that arrived and departed with cargoes and in ballast from and to foreign countries and British possessions and coastwise during the calendar year of 1912 was 37,676,142 as compared with 39,179,153 in the year ended December 31, 1911. The net registered and dock cargo tonnage of ships that entered and left the port and paid river tonnage dues during the twelve months ended March 31, 1913, compared with the preceding twelve months, were as follows: 1913, foreign, 19,632,865; coastwise, 8,875,807; total, 28,508,672. 1912, foreign, 20,101,634; coastwise, 9,393,887; total, 29,495,521. The shipping that use the wet docks and paid river tonnage dues, exclusive of vessels to and from the estuary and Medway, was: foreign, 15,179,104 tons as compared with 15,585,453 tons in the preceding fiscal year; coastwise, 1,979,328 tons as compared with 1,989,095 tons in 1911-1912; total, 17,158,342 tons as compared with 17,574,548 tons in 1911-1912. The shipping entering the dry docks of the Authority during 1912-1913 was 114,899 tons less than that of the preceding year, the tonnage being 2,158,073 in 1911-1912 and 2,043,174 in 1912-1913. During the year under review contracts were entered into in connection with the Dock Improvement scheme, representing an expenditure of about $12,190,582 (£2,500,000). The principal improvements consisted of the building of sheds, the erection of hydraulic and electric cranes, the installation of a power plant (at the Millwall dock), the provision of additional warehouse space, the furnishing of better railway accommodation and the reconstruction of a grain elevator.

City of Rome Destroyed by Fire.—The freight steamer *City of Rome*, bound from Buffalo to Toledo, was totally destroyed by fire May 7. The fire was discovered in the forward hold of the vessel shortly after midnight, and the vessel was immediately headed for the nearest shore, although before reaching the shore the crew was forced to take to the boats and abandon the vessel. The *City of Rome* was built in 1881. She is 265 feet long, with a capacity of 3,500 tons. Captain William Dunn commanded the vessel; Thomas Cunningham, of Milwaukee, Wis., had charge of the engine room, and C. E. Derew, of Chicago, was assistant engineer.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

A Condenser Breakdown

The illustration shows a condenser which broke down recently on board a steamer engaged in cross-channel service. It also shows that in repairing it a very elaborate casting was dispensed with which at the time the condenser was designed (about twenty-five years ago) was considered to be the correct thing.

The condenser was of cast iron and of the double-flow type. The cooling water entered the water-box at the inlet *A*, and flowed through in the direction shown by the arrows. The

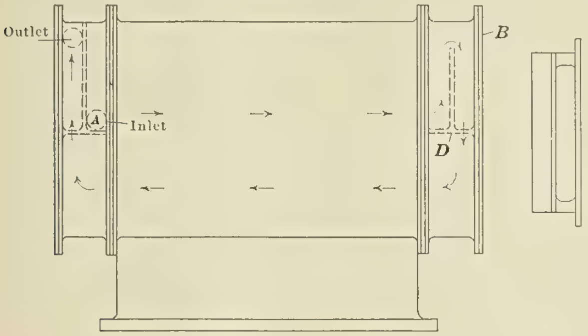


Fig. 1 Fig. 2

circulating pump was driven off the main engine, and one night in heavy weather the door *B* cracked badly. However, good stout shores were put in between one of the engine columns and the door, enabling the ship to get into port. She was due to sail again the next day, but the door was found to be so badly damaged that it was quite impossible to patch it.

A ¾-inch thick malleable iron plate was sheared to shape, drilled and put on without the partition *D* with vertical baffle plate, which was cast on the old door. The vessel sailed next morning, and the condenser proved just as efficient as ever. Fig. 2 shows a plan of the original door. J. SWAN.

Further Remarks on the Corrosion of Boilers Using Sulphurous Oils

Referring to my previous notes on the "Corrosion of Boilers Through the Use of Sulphurous Oils," published in the May number of this paper, the following supplementary remarks are submitted:

Since writing the first notes I have attempted to prove that the formation of sulphuric acid, as stated therein, is entirely practicable. My apparatus has not been of the best, so it has not been possible for me to duplicate the conditions found in the furnace, but my results have been fairly satisfactory.

In my first experiments I burned a small quantity of sulphur (about 1 gram) in a vessel containing practically pure oxygen and in which I had previously placed several pieces of sulphur-free firebrick. After the sulphur was burned the vessel was placed in an oven and kept at a temperature of 125 degrees C. for about two hours. At the end of this time the pieces of brick were removed and placed in a beaker containing distilled water. The liquid was filtered off after a suitable length of time had elapsed, and a little barium chloride was added to it. The white precipitate of either barium sulphate, barium sulphite, or both, promptly appeared. In order to eliminate the sulphite, the precipitate was boiled with hydrochloric acid. Although the greater part of the precipitate disappeared during this boiling enough remained to show that a small quantity of sulphuric acid had been present in the liquid.

As a further experiment, about 2 grams of sulphur was burned in air in an oven in which pieces of firebrick had been placed. In order to cause the sulphur to burn at a high temperature, as it would do in the furnace, it was ignited by dropping it upon a hot iron plate placed in the oven for this purpose. An oven temperature of 130 degrees C. was then maintained for about two hours. At the end of this time the brick was tested as before with practically the same results.

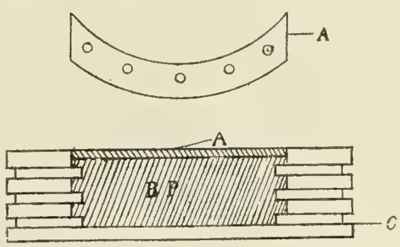
The sulphite reaction above mentioned was caused by the presence of considerable quantities of SO_2 (the principal product of the combustion of sulphur in air) in the brick. This reaction was to be expected. In each case, however, there was a small amount of sulphuric acid present, which tends to confirm the theory given in the May number of this paper.

In my previous notes I neglected to say that the white precipitate formed by the action of $BaCl_2$ might be either a sulphite or a sulphate, and that it is necessary to eliminate the sulphite by boiling with hydrochloric acid. Of course, there are some other compounds which might cause a similar reaction, but their presence is not to be expected in a boiler under ordinary circumstances. As a means of acquiring certainty in every case of doubt it is well to submit samples of the material to be tested to a chemist for analysis. The analysis is simple, would not be expensive, and would probably be a good investment in the end. W. W. B.

Successful Arrangement of Piston Rings on Horizontal Marine Engines

Horizontal engines on board ship differ from those ashore in this respect, that the engine-room space on board ship is limited and no tail rod with guide can be fitted to keep the piston on the center of the cylinder. Therefore, there is generally excessive wear along the bottom side of the cylinder and piston.

The illustration shows how this can be remedied. After running for a short time, the piston of a horizontal engine becomes such a good fit for the cylinder along the bottom side that you could dispense with the ramsbottom rings or



Arrangement of Piston Rings

other packing on the bottom. Working on this idea, the sketch shows how the pistons of a paddle engine were altered and now give the engineer no trouble.

The pistons were taken up to the shop and for about a fourth of their circumference were slotted out to the depths of the ramsbottom ring grooves, but not right through the whole depth of the piston, the cut being stopped at the face of the last groove, as shown at *C*. The bronze plate *B P*

was then fitted into this. The junk ring was cut out in the top to a depth of ⅝-inch to receive a bronze locking plate *A*, which was held in position by the junk ring studs.

When the piston was in position, the ends of the bronze plates were perpendicular and parallel to one another in order to permit packing being slipped in between the plate *B P* and the piston to make up for any wear and still keep the ends a good fit to the piston. The ramsbottom rings were cut so that they would project into the plate *B P* about 1 inch. The plate *B P* was not pinned on to the piston in any way, but was just held in position by the locking plate *A*.

Those pistons ran so successfully that the other paddle engines in the same fleet were altered accordingly.

J. Swan.

Air Pumps

The writer was reminded by one of the questions in the final chapter of "McAndrew's Floating School" in the April issue of the International Marine Engineering of some experiences he has had with air pumps, the relation of which may prove interesting to all and possibly instructive to the younger marine engineers.

One of the first vessels he served on was an old wooden coastwise ship, fitted with a single engine which originally was jet condensing, but at this period a surface condenser had been installed. The air pump was attached to the main engine crosshead, and was not altered any when the surface condenser had been installed, except to change the suction channel. Having been designed for jet condenser duty, thus having to take care of the condensing water as well as the vapor and condensed steam, it was considerably larger than was necessary for surface condenser duty, a meritorious fault, by the way. The peculiar circumstance connected with this air pump was that it was not fitted with a foot valve. The bucket and delivery valves were single valves, made of soft rubber, fastened in the center, and at each stroke of the pump they curled up at the edges around a convex guard. This air pump performed all the duty required of it in a perfectly satisfactory manner without a foot valve, 28 inches of vacuum being maintained in the condenser without any difficulty. Being of such ample size there was little trouble experienced with the valves or packing, and the writer has never known of an air pump that gave better service with as little trouble than did this one.

On another ship of the same type the air pump was also of large size, having been installed for jet condenser duty but used after a surface condenser had been installed. This pump was fitted with foot, bucket and delivery valves, all of the single type as described in the first part of this article. While proceeding down the James River, Va., the delivery valve carried away just as the ship was making a landing. When the ship had been made fast to the dock the bonnet over the delivery valve was taken off, when it was discovered that the convex guard was broken beyond repair and the valve torn in several pieces. There was no spare guard on board, but the chief engineer decided that the trip home could be made without a delivery valve, and when the debris had been removed from the valve chamber the bonnet was replaced and the voyage continued. So far as could be noticed this air pump worked as satisfactorily without this valve as it ever had done with it, the same vacuum being maintained the remainder of the trip. The writer, then a young man, asked the chief why this delivery valve could not be done away with entirely, and was informed that if the foot valve carried away with the delivery valve in good condition the air pump would continue to perform duty, but without the delivery valve in case of accident to the foot valve the air pump would be useless, a piece of information that was valuable to a young man learning the business.

Some years later, when the writer had advanced in his profession, he was chief engineer of a coastwise tugboat, fitted with triple-expansion engines with the air pump attached to the intermediate-pressure crosshead. This air pump was of the usual type of modern construction, having six straigh lift valves each in the foot, bucket and delivery. One afternoon the assistant engineer reported that the vacuum had suddenly disappeared. No difficulty was experienced in locating the trouble. The steam was being properly condensed and there were no air leaks anywhere, so that the only explanation was that a bucket valve had carried away. The water was flowing through the air pump and hotwell to the filter box, whence the feed pumps were taking it and putting it back into the boilers, so it was decided to proceed on the voyage, as it would be extremely inconvenient, if not hazardous, to stop for repairs with a tow of barges at this time and place. The voyage was completed without difficulty, the engines only making five or six revolutions less per minute on account of the loss of the vacuum. On arrival in port the air pump was stripped and a stud in one of the valves was found to have pulled out of the grating in the bucket. The guard was badly battered out of shape but no other damage done. Spare guards and valves were carried on board and the hole in the grating was reamed out and tapped larger, a special stud made with end to fit and the air pump was soon in shape again.

These experiences show that an air pump will work without either a foot or delivery valve but not without both, nor will it work without the bucket valve being in proper condition.

J. S.

The Loss of the Oklahoma as Viewed by the Bureau Veritas

The administration of the Bureau Veritas have had their notice drawn to the findings of the Local Inspectors at Boston, Mass. (as reported to the Supervising Inspector General, Steamboat Inspection Service, Washington, D. C.), on the loss of the steamship *Oklahoma* on January 4, 1914. In their findings the Local Inspectors state that the loss of this vessel "demonstrates the fact that the rules of the Bureau Veritas may be faulty," yet an examination of the findings, based, no doubt, on the evidence given by the survivors of the crew, fails to show that there was any definite reason for coming to such a decision.

The facts of the case are briefly as follows: The steamship *Oklahoma* left the docks at Bayonne at about 1 P. M., January 3. She had ballast in Nos. 4, 6 and 7 tanks and fuel oil in No. 2 wing tanks, and also in the fore peak. On the way down the Bay No. 5 tank was cleaned out and was apparently ready to receive water ballast shortly after the vessel passed the Scotland Lightship, at about 3 P. M. Outside, the sea was found to be rough and the wind blowing hard. The condition of the weather was such that after passing outside the vessel was slowed down to a speed only sufficient to keep her head to the wind. This clearly proves, when such a large vessel as the *Oklahoma* had to be nursed so carefully, that the weather conditions were rather severe. The captain decided to take in more water ballast, and No. 5 tank was pumped up. The grave risks taken by such a procedure will be commented on hereafter. The weather gradually grew worse during the night. The wind was almost of hurricane force and mountainous seas were running. Early on the morning of January 4, two other tanks, Nos. 3 and 8, were pumped up, and this was not completed until some time after 4 A. M., *i. e.*, over thirteen hours after passing the Scotland Lightship. The ship made very bad weather all night, as the decks were awash and the vessel almost hove to. At about 7 A. M., on January 4, some of the officers and crew noticed a slight buckling of the deck in way of No. 5 tank

which they did not think was serious. About 9 A. M. the same morning, while the vessel was poised on two seas, the vessel broke completely into two parts in way of No. 5 tank, which is near amidships.

The grave risks and dangers of damage to the structure of the vessel by pumping in large quantities of water ballast under such severe weather conditions are readily acknowledged by those best able to judge, and so clearly is that recognized that the rules of the Bureau Veritas specify that one of the conditions of the classification of such vessels is that: "It should be understood that on no account is water ballast to be pumped in or out of the holds or cofferdams at sea, beyond that which is necessary for keeping tanks full in case of leakage." Therefore, it is clear that the conditions of classification were violated in this instance. That such severe treatment of the structure of the vessel contributed greatly to the eventual failure will be readily admitted, yet there is no mention of this grave risk in the official report. In fact, it is inferred that it was a quite proper procedure to take.

There may be extreme cases where the masters of such vessels have to take such risks, as a last resource, but if the structure fails under these trying circumstances, that does not prove that the rules of the registration society to which the vessel was built are faulty. The administration have stated the facts, as known by them, regarding the severe treatment to which the structure of the vessel was subjected, and they feel sure that when these facts are placed before anyone, in a position to form an intelligent opinion on the matter, they would unhesitatingly confirm the administration's opinion that this severe treatment very likely led to the breaking in two of the vessel.

It is very strange, too, that in hinting at the faultiness of the rules of the classification society to which the vessel was built, little or no notice has been taken of the past performances of the vessel. The vessel was built in 1908 at Camden, New Jersey, since when she has been regularly employed in the carriage of oil cargoes. On her preceding trip the ship had delivered a cargo of refined oil, consisting of several different grades, the character of which would not permit of even the slightest mixture. This indicates that the bulkheads were in good condition. This cargo of oil was delivered practically free of any water, and without loss, proving that no sea water had leaked in and that no oil had leaked out through the shell. Moreover, the vessel had made a great number of successful trips across the North Atlantic, during some of which she experienced much worse weather and higher seas than existed at the time of her loss. With such a record of good service to her credit, it seems very unreasonable to infer that the rules to which she was built may be faulty, and that the loss of the vessel may be attributed thereto.

This surely points to some other cause for the failure of the vessel's structure, and gives good grounds for the suggested reason, as stated above. It is also interesting to note that the captain and officers of this vessel never had occasion to notice any weakness whatever in the vessel, prior to the morning of her loss, and they considered the vessel strong and seaworthy.

With reference to the statement in the finding, "that because a small amount of re-riveting was necessary at different times during the life of the vessel, this demonstrates and proves that there was unusual work and motion in the hull of the ship," it is clear that the local inspectors who drew up the official report are not conversant with the work usually necessary for the upkeep of such vessels. Every bulk oil-carrying vessel has to have the riveting of the tanks overhauled from time to time, but this in no way proves that the structure of the vessel is weak.

The shipping world will be interested to have further information as to the standard of construction that the local inspectors wish to set up, and also on what experience that standard is to be based. If it is to be a standard which will make the vessels "capable of enduring, without damage to the structure, every possible strain which might be brought to bear upon it, without restriction," such as the filling of tanks with water ballast in bad weather, then the owners of such vessels must be prepared for a very considerable increase in the weight and cost of such vessels trading to United States ports in the future. That such increases are not justifiable is readily proved by the successful running of the large number of bulk oil-carrying vessels which are constructed to the rules of the various classification societies. The rules of these societies have been built up from long experience, yet no classification society would venture to guarantee that the structure of a bulk oil-carrying vessel built to its rules would be immune from failure if subjected to extreme treatment outside of that usually accepted as fair and reasonable and as a condition of classification. BUREAU VERITAS.

New York, N. Y.

An Interesting Boiler Repair

The twin-screw steamship *Canada*, 11,440 tons, of the Austro-American Line, is one of the largest vessels entering Montreal harbor during the present season. She is, moreover, one of the largest emigrant ships in the world, having accommodation for over 3,000 steerage passengers, together with a crew of 160.

The *Canada* is propelled by quadruple expansion engines fitted with Walschaert valve gear, and steam 215 pounds pressure is raised in four boilers of the Scotch type. Each of the latter has three furnaces, the two center boilers being single-ended, while the port and starboard boilers are double-ended. On the ship's first voyage to Montreal from Trieste last season, she met with a mishap which put the port boiler out of commission. She had a very light cargo on that trip, and was only drawing 13 feet forward and 21 feet aft, as against her normal draft of 30 feet when fully loaded.

The incident took place in the afternoon when off the Banks of Newfoundland. The *Canada* had on board 2,300 passengers, the majority of whom were on deck at the time. A strong northeasterly wind sprang up suddenly, and as there were numerous icebergs in the vicinity this wind was very cold, causing the passengers to make a concerted rush to the lee side of the deck houses. This movement, combined with the strong wind, gave the vessel a bad list to port, with the result that the crown sheet of the starboard combustion chamber of the port boiler became overheated and collapsed.

There were 3 inches of water in the glass at the time, and directly the ship listed extra feed was given to all the boilers. At the same time the starboard tanks were filled as rapidly as possible in an endeavor to bring the ship again upon an even keel. These measures took about ten minutes, by which time the crown sheet of the combustion chamber in question had been badly burned. It collapsed in pockets between the staybolts, causing the holes of the latter to become enlarged, although the bolts did not actually pull out. There was, however, a serious leakage of steam and water into the furnaces.

The ashpan and up-take dampers were immediately closed, and the fires drawn. The latter operation proved rather a difficult one owing to the escaping steam, but fortunately no one received injury.

MAKING THE REPAIR

The voyage was continued with three boilers, and on Montreal being reached repairs to the damaged combustion chamber were at once undertaken by the Hall Engineering Works of that city.

The combustion chamber top was 4 feet 2 inches wide by 5

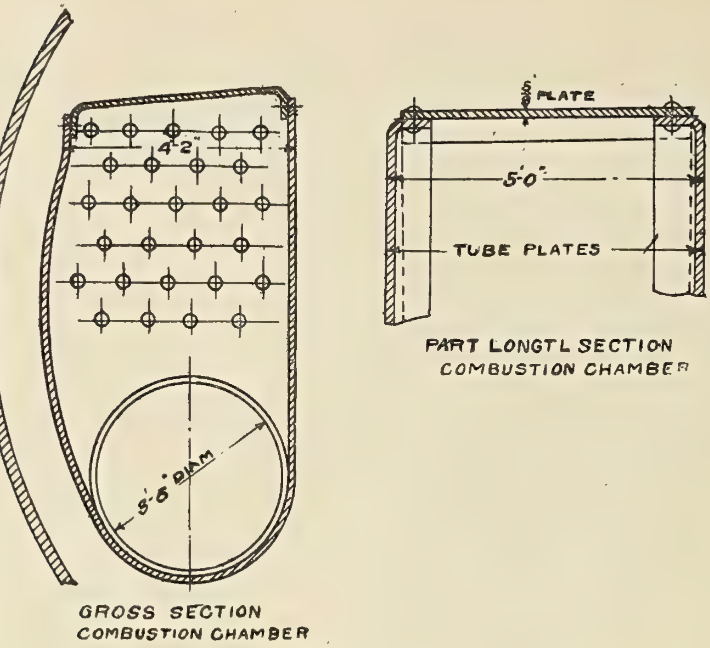


Fig. 1

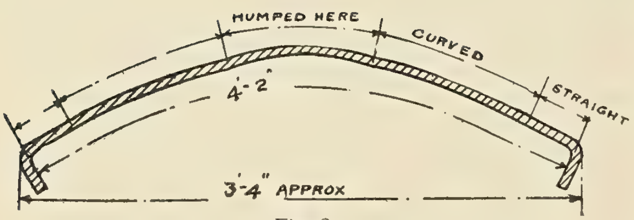


Fig. 2

feet long, and it was desired to have the new crown sheet made from a single plate, but the internal diameter of the corrugated furnace was only 3 feet 6 inches, so that at first sight there seemed to be no choice but to use two plates and have a riveted joint along the top of the chamber. Such a joint would, of course, have been highly undesirable in such a location, and the manner in which the necessity for it was overcome is shown in the accompanying cuts.

The crown sheet, it should be mentioned, was 5/8 inch thick and of ordinary boiler plate quality—60,000 pounds tensile strength. It was flanged on two edges to make the joint with the combustion chamber side sheets, as indicated in Fig. 1. In order to get it through the flue it was determined to roll it to a curve, as shown by Fig. 2. A piece of 1/8-inch plate was first taken and cut to the dimensions of the crown sheet. This plate was then flanged, so that it formed a true templet of the heavier plate. It was then put through a set of rolls and various trial curves given to it until it would pass easily through the flue. The curve did not extend the full width of the plate, a portion of the latter being left flat near each of the two flanges. A rather sharper radius was given along the longitudinal center line than elsewhere, the general shape of the curve being shown in Fig. 2.

The templet having been satisfactorily shaped, the crown sheet was rolled to the same curvature. It was then transported from the Hall Engineering Works to the ship, where it easily passed through the furnace flue into the combustion chamber.

The next step was to raise the plate and place it upon the top of the forward tube sheet with the flanged edges in a fore-

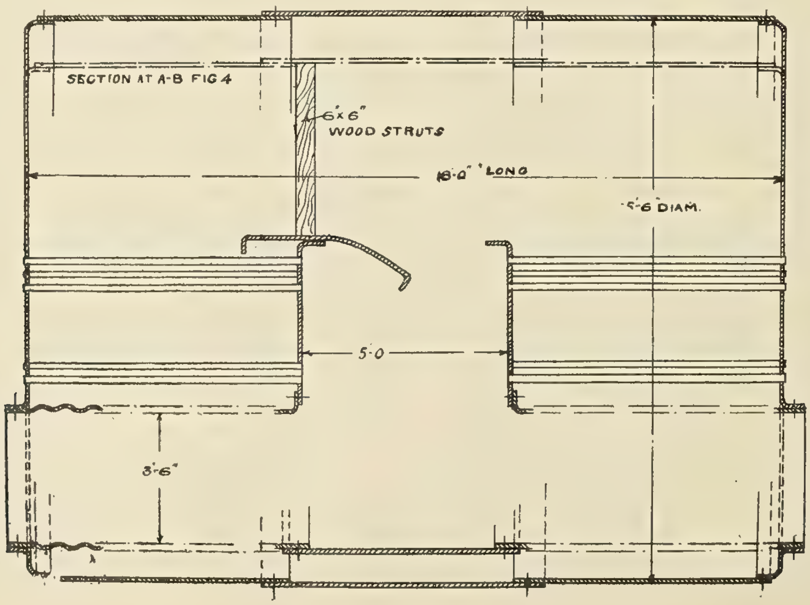


Fig. 3

and-aft direction; that is, in a position at right angles to the direction they were to eventually occupy. This is shown in Fig. 3.

Straightening the Plate

The plate having been got into the position indicated, stout timber struts were fitted between it and the boiler shell. These served to hold it securely while one-half was gradually straightened out by hydraulic jacks. When this had been satisfactorily accomplished, the plate was removed to a similar position on top of the other tube sheet, and the straightening operation repeated on the other half. The plate was practically straightened cold, it only having had "the chill taken off," in order to avoid the risk of setting up serious stresses in the metal.

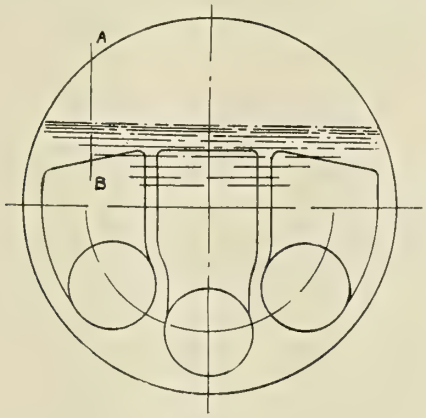


Fig. 4

All that now remained to do was to turn the plate round into its final position and drill it for the rivet and staybolt holes. The rivets were then driven, the girder stays replaced, and, in just a week's time from the commencement of the job, the boiler was ready for steam again. Of course, work was carried on night and day; but, even so, the performance was a good one. Turning the plate around and afterwards straightening it were two very awkward operations in the cramped quarters afforded by the combustion chamber; and that the work was satisfactorily accomplished speaks well for the facilities to be found at the port of Montreal, and the resourcefulness displayed and the emergency equipment available at the Hall Engineering Works there.—*Canadian Machinery.*

Marine Engineering Academy

The Marine Engineering Academy, 80 Broad street, New York City, formerly owned by Theo. T. Mercereau, is now under the management of Educational Department of the West Side Y. M. C. A. of New York City. The academy was established in 1904 by Thomas H. Barrett, and was subsequently taken over by Theo. T. Mercereau, under whom more than 700 men have been trained to become marine engineers. The new management has taken up the work of training men to become marine engineers not solely upon the advice of men who have had experience in this particular phase of education, but also upon the counsel of prominent steamship men, who have welcomed the event of reorganizing and continuing the academy, as a means through which they may secure more efficient and better trained engineers.

In order to make it easier for men to secure licenses as marine engineers a thorough course of instruction has been planned to meet the difficulties most often encountered by candidates. The school will cater not only to local patronage but to the future engineers of the entire country. Through investigation it has been found that there are men throughout the country who hesitate to come up for an examination because they feel that there is some requirement, such as mathematics, which they would not be able to pass, and they are unwilling to place themselves in a position to be humiliated by failure. On account of a total ignorance of the actual topics touched upon by the examination the tests appear much more formidable than they really are. The object of the school is to encourage and assist any such hesitating men. They will be given the needed instruction along the line of the questions asked, and will be coached in the proper manner of going about securing their licenses. The course planned deals exhaustively and thoroughly with the various mathematical calculations marine engineers are called upon to make.

Mr. Mercereau will remain with the school in the capacity of advisor, and Mr. John L. Moran will be the instructor in the new course. The advisory committee consists of Robert E. Todd, ex-commodore, Atlantic Yacht Club; Arthur Curtis James, ex-commodore, New York Yacht Club; Capt. George S. Runk, member Larchmont Yacht Club, and Edward L. Wertheim, educational director of the West Side Y. M. C. A.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		Feb. 1.	May 1.
New York	28,000	21	Navy Yard, New York	96.4	100.0
Texas	28,000	21	Newport News Shipbuilding	98.3	100.0
Nevada	28,000	20½	Fore River Shipbuilding Co.	55.2	63.9
Oklahoma	28,000	20½	New York Shipbuilding Co.	60.8	67.2
Pennsylvania	31,400	21	Newport News Shipbuilding	17.0	29.1
No. 39	31,400	21	Navy Yard, New York	4.7	11.5

TORPEDO BOAT DESTROYERS

Downes	1,010	29	New York Shipbuilding	93.7	95.3
Balch	1,010	29	Wm. Cramp & Sons	92.6	100.0
O'Brien	1,050	29	Wm. Cramp & Sons	42.1	62.2
Nicholson	1,050	29	Wm. Cramp & Sons	42.1	60.5
Winslow	1,050	29	Wm. Cramp & Sons	40.3	54.4
McDougal	1,050	29	Bath Iron Works	66.6	89.3
Cushing	1,050	29	Fore River Shipbuilding	32.0	41.5
Ericsson	1,050	29	New York Shipbuilding	40.9	61.6
No. 57	1,090	29½	Fore River Shipbuilding Co.	6.8	9.4
No. 58	1,090	29½	Wm. Cramp & Sons	2.6	6.8
No. 59	1,090	29½	Wm. Cramp & Sons	2.5	6.7
No. 60	1,090	29½	Bath Iron Works	7.2	17.5
No. 61	1,090	29½	New York Shipbuilding Co.	8.9	9.8
No. 62	1,090	29½	New York Shipbuilding Co.	8.9	9.8

SUBMARINE TORPEDO BOATS

G-4	....	....	Wm. Cramp & Sons	96.4	96.4
G-2	....	....	Newport News Shipb'g Co.	89.7	89.7
G-3	....	....	Lake T. B. Co.	80.3	81.6
K-1	....	....	Fore River Shipbuilding Co.	99.2	100.0
K-3	....	....	Union Iron Works	91.7	94.0
K-4	....	....	Seattle Con. & D. D. Co.	89.4	93.9
K-5	....	....	Fore River Shipbuilding Co.	88.9	92.8
K-6	....	....	Fore River Shipbuilding Co.	88.7	92.8
K-7	....	....	Union Iron Works	83.6	88.9
K-8	....	....	Union Iron Works	83.0	88.4
L-1	....	....	Fore River Shipbuilding Co.	22.8	30.3
L-2	....	....	Fore River Shipbuilding Co.	22.5	30.3
L-3	....	....	Fore River Shipbuilding Co.	22.5	30.3
L-4	....	....	Fore River Shipbuilding Co.	22.4	30.2
L-5	....	....	Lake T. B. Co.	7.4	8.1
M-1	....	....	Fore River Shipbuilding Co.	14.1	20.8
L-9	....	....	Fore River Shipbuilding Co.	0.0	1.9
L-10	....	....	Fore River Shipbuilding Co.	0.0	1.9

COLLIERS

Kanawha	14,000	14	Navy Yard, Mare Island	31.5	49.0
Maumee	14,000	14	Navy Yard, Mare Island	17.5	25.9

Trials of the United States Destroyer McDougal.—On her official trials, held early in May, the United States torpedo boat destroyer *McDougal,* built by the Bath Iron Works, Bath, Me., averaged for five full-speed runs over the Rockland measured mile a speed of 31.516 knots. The highest speed obtained was 32.07 knots.

ENGINEERING SPECIALTIES

Kingston Dredger and Excavator

Messrs. Rose, Downs & Thompson, Ltd., of Hull and London, E. C., design and manufacture self-propelled steam hopper barges equipped with two or four Kingston dredges fixed fore and aft of the hopper well. The illustration shows a 500-ton hopper barge with two fixed dredgers and separate propelling engines and a marine boiler. Dredgers of this description can be supplied capable of a total output of from 2,000 to 5,000 tons. The principal advantages of this type of dredger over the more costly ladder dredgers are general handiness, ability to dredge among shipping and along door walls, and the low cost of repairs and operation. With this type of dredger stopping for repairs is avoided, as in the event of one machine giving out the others can continue working. Steam is supplied direct from the marine boiler to the Kingston dredging machines fixed fore and aft of the hopper.

Results from Service Tests of Eckliff Boiler Circulators and Purifiers

Trouble from scale formation led to the recent installation of seventeen circulators and purifiers manufactured by the Eckliff Automatic Boiler Circulator Company, Detroit, Mich., in a number of Scotch and fire-box boilers on dredges and tugs owned by the Great Lakes Dredge & Dock Company of Chicago. Before the installation of these circulators the heating surfaces of the boilers were coated with a heavy accumulation of scale, which greatly impaired the efficiency and economy of the boilers. After the circulators were installed the scale gradually peeled off until the heating surfaces were practically clean and, by the operation of one blow-off valve on each boiler for a period of 30 seconds every 6 hours, it was found that no further scale formed on the heating surfaces and that the boilers could be operated indefinitely without washing. In addition to the above results the consumption of fuel was reduced to a remarkable extent, in some cases as much as 15 percent.

The first installation was made on September 14, 1913, in a three-furnace Scotch boiler 11 feet 6 inches diameter by 13 feet long, on the tug *J. McCarty*, which was operated in the Chicago drainage canal and vicinity towing scows and dredges. Previous to the installation of the circulator and purifier on this tug so much mud accumulated in the bottom of the boiler in one week's operation that it was necessary to wash the boiler once every seven days, and the fuel consumption covering a period of 30 days was 1,360 pounds per hour. At the end of 30 days' operation, after installing the circulators and purifiers, it was found necessary to open the boiler and remove the accumulation of hard scale that had peeled off the furnaces and tubes. The boiler was then closed and operated continuously for six weeks before a sufficient quantity of hard scale had again accumulated to interfere with the automatic removal of the soft residue in the bottom of the boiler. At that time a thorough examination of the tubes and furnaces was made and they were found to be almost entirely free of any scale formation.

During the first 30 days following the installation of the circulators and purifiers the average fuel consumption was only 1,240 pounds per hour, or 9 percent less than before the circulators and purifiers were installed. As the balance of the scale continued to peel from the heating surfaces, the fuel consumption was further reduced so that the last records available show a reduction of 15 percent.

The Eckliff system of circulators and purifiers is totally independent of all feed pipes and any other connections on the boiler. The results obtained were accomplished without the use of any chemical or mechanical means, and the removal of the scale from the tubes and furnaces was brought about solely by the conditions created inside the boiler by the circulators. Scale formation on the heating surfaces of a boiler equipped with Eckliff circulators and purifiers, it is claimed, is positively prevented because the feed water is purified in-

side of the boiler below the level of the grates, and all of the solid residue contained in the feed water is precipitated to the bottom of the boiler away from any heating surfaces, where it remains in the form of soft sludge until automatically blown out of the boiler.

In the case of the tug *J. McCarty*, the feed water was taken directly from overboard and delivered to the boiler without having passed through any exterior feed water purifiers and was heated only in an exhaust heater to a temperature not exceeding 190 deg. F. Immediately following the installation of the circulators and purifiers this boiler was filled with water at a temperature of 70 deg., and within 45 minutes after the fires were lighted in the three furnaces the steam gage indicated 120 pounds pressure. The thermometer, which was attached to the boiler so that the mercury bulb was between the bottom of the combustion chamber and the boiler shell, and completely surrounded by the water contained in the boiler, indicated a temperature at the extreme bottom of the boiler of 337 deg. F. Fifteen minutes later the steam gage indicated a pressure of 165 pounds and the temperature of the boiler under the combustion chamber was 368 deg. F. Considering the fact that the ordinary Scotch boiler must be fired very gradually from 12 to 24 hours before steam is allowed to generate, this test indicates the rapidity and positiveness of the circulation induced in a boiler equipped with the Eckliff system of circulators. Owing to the fact that the temperature of the contained water is equalized at all times throughout the boiler, this rapid firing can be done without injury to the boiler, as the strains due to unequal expansion and contraction are entirely eliminated. It is also found that through the equalization of temperatures throughout the boiler pitting, grooving, corrosion, breaking of staybolts and the formation of furnace cracks are prevented, while the girth seams of the boiler remain dry and tight.

As the result of the test in the tug *J. McCarty* the Eckliff system of circulators and purifiers has been installed in one fire-box and thirteen Scotch boilers on other dredges and tug boats owned by the Great Lakes Dredge & Dock Company.

A Large Order for Dredger Pins

Messrs. Edgar Allen & Company, Ltd., Imperial Steel Works, Sheffield, have filled an order from the Argentine Government for 43 tons of dredger pins to be made from Allen's Imperial manganese steel. The characteristics of this steel, such as its extreme toughness, combined with hardness, make it a particularly suitable material for dredger pins, and also for other wearing parts of dredgers, such as bucket lips, corner pieces, bushes, elevator chain links and many other parts of crushing and grinding machinery.

Personal

JOSEPH W. POWELL, formerly assistant to the president of Wm. Cramp & Son's Ship and Engine Building Company, Philadelphia, Pa., has succeeded Rear Admiral Francis T. Bowles as president of the Fore River Shipbuilding Corporation, Quincy, Mass.

D. E. FORD, for twenty years naval architect and superintending engineer of the Standard Oil Company, New York, has opened an office as consulting engineer, naval architect and ship and engine surveyor and appraiser in San Francisco, Cal.

CLARENCE BAILEY, of Albany, N. Y., has been appointed chief engineer of the Hudson River Day Line steamer *Albany* on the retirement of Cornelius Midlam, who was probably the oldest active engineer on the Hudson River. Edward Van Heusen, of New Baltimore, N. Y., will be Mr. Bailey's first assistant engineer.

FRANK W. SEAMAN has been promoted from first assistant engineer to chief engineer of the steamer *Berkshire* of the Hudson Navigation Company, succeeding Thomas D. Borne, chief engineer of the *Adirondack*, who has been acting chief engineer of the *Berkshire* since the death of the former chief engineer, David Allardice.

P. J. KILLION, formerly with the Albany Towing Company, has been appointed chief engineer of the tug *Colonel Stair*. This tug was formerly named the *George D. Cooley*, but was renamed when bought recently by the United States Government for the upper Hudson River improvement. The tug will be commanded by Captain James Allen, formerly with the Newburgh Dredging Company.

HENRY STAMMELL, formerly of the Albany Towing Company, has been appointed chief engineer of the passenger steamer *Hudson Taylor*, commanded by Captain Edward McCabe. The *Hudson Taylor* has been placed on the route between Albany and Troy, N. Y., by the Central Hudson Line, carrying the freight formerly handled by the larger boats which went to Troy in the evening.

BURTON COLVIN has been appointed chief engineer of the *Augustus Phillips*. This vessel, which formerly ran on the Albany and New Baltimore route, has been taken over by new owners, and will hereafter be operated on the longer route between Coxsackie and Albany, N. Y., stopping at way landings. Captain Charles Hovey, of Schodack, N. Y., will have command of the vessel.

EDWIN FITZGERALD has been appointed chief engineer of the steamer *St. Johns*, owned by the Potomac & Chesapeake Steamboat Company, Washington, D. C. This boat will make her first trip to Colonial Beach May 30. Captain Chapman Sly is in command of the vessel.

A. L. GEEN has been appointed chief engineer of the steamer *Frederick Du Barry*, recently purchased by the Potomac & Chesapeake Steamboat Company from a steamboat company on the St. Johns River, Florida. This boat will be placed on the Colonial Beach route on the Potomac River as soon as repairs, made necessary by the stormy passage up the Southern coast from St. Johns River to Washington, are completed. The vessel will be commanded by Captain W. L. Davis.

F. P. O'DONNELLE has been appointed chief engineer and Captain George Windsor commander of the steamer *Charles Maccalister*, of the Mt. Vernon & Marshall Hall Line, Washington, D. C.

H. F. JOHNSON, first lieutenant of engineers, who is now chief engineer on the revenue cutter *Apa he*, which arrived in Washington, D. C., from Baltimore, Md., on May 16, and is again on a cruise in Chesapeake Bay, will soon be detached and ordered to service on the revenue cutter *Gresham* on the Boston station. Second Lieutenant of Engineers E. S. Adison, who has been on duty on the revenue cutter *Guthrie*, will take Lieutenant Johnson's place in charge of the engines of the *Apache*.

Obituary

ALEXANDER B. SCULLY, president of the Scully Steel & Iron Company, Chicago, Ill., died suddenly at his home in Chicago May 7, aged 58.

WILSON B. CHISHOLM, president of the Champion Rivet Company, Cleveland, Ohio, died May 10 after a protracted illness, aged 65.

JAMES SHEWAN, Sr., head of the dry dock firm of James Shewan & Sons, Brooklyn, N. Y., died at his home in New York May 7 at the age of 66.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,088,079. ENGINE GOVERNOR. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

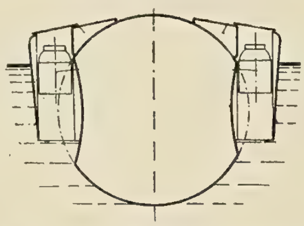
Claim 1.—In an automobile torpedo a governor comprising a driving part, a rotor driven therefrom, interposed gearing, including a member movable with variations in the resistance offered by said rotor, and speed-controlling means operated by the movements of said movable member. Twelve claims.

1,089,338. LIFE-RAFT. ERNEST R. GREENE, OF HANOVER, N. H.

Claim 1.—In a life-raft, a framework, a buoyant member carried by said framework, a continuous, flexibly mounted piece of waterproof material secured to said framework, and a waterproof body portion or hull secured to said piece on a line between its top and bottom. Seventeen claims.

1,089,543. SUBMARINE BOAT. FERNAND FENAUX, OF LE HAVRE, FRANCE, ASSIGNOR TO CHANTIERS ET ATELIERS AUGUSTIN NORMAND, OF LE HAVRE, FRANCE, A CORPORATION OF FRANCE.

Claim 1.—A submarine boat provided with a series of mine retaining cells, said cells provided with upper and lower openings to permit the



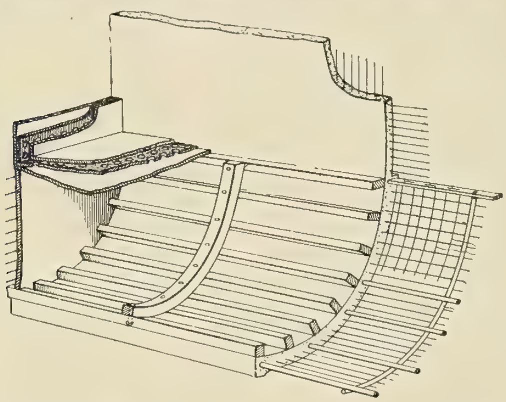
mine to be moored in an upward or downward direction. Three claims.

1,089,405. REINFORCED CONCRETE DOCK OR PIER. WILLIAM S. FERGUSON, OF CLEVELAND, OHIO, ASSIGNOR TO J. D. CAREY, OF CLEVELAND, OHIO.

Claim 1.—In a concrete dock, a foundation of upright piles, metallic rods crossing the upper ends of said piles, a second set of metallic rods at right angles to said first-named rods, a concrete structure formed upon said rods and incorporated therewith, said structure comprising a front wall and a base, bracing walls connecting said front wall and base adapted to support the compression strain, and means inserted in said bracing wall for supporting the tensile strain. Sixteen claims.

1,090,349. BOAT CONSTRUCTION. HARVEY ELVIN SMITH, OF REPRESA, CAL., ASSIGNOR OF ONE-HALF TO ROBERT C. JOHNSON, OF REPRESA, CAL.

Claim.—A device, including a concrete hull having a keel, lengthwise running reinforcing rods having eyes embedded in said hull, embedded transverse U-shaped strut rods passing through said eyes, oppositely positioned apertured bars embedded within said hull, the ends



of said strut rods being secured within apertures of said bars, lengthwise running reinforcing wires embedded within said hull below said strut rods, and a plurality of strut wires threaded through the apertures of said bars and intertwined between said reinforcing wires. One claim.

1,090,271. PROPELLER. CHESTER A. BRYAN, OF HALL CITY, FLA.

Claim 2.—In combination, a propeller hub having oppositely arranged dove-tailed recesses which are tapered longitudinally, propeller blades having bases shaped correspondingly with regard to the recesses and fitted therein, the bases having teeth, spring members secured in the recesses having lateral portions to engage the teeth to prevent longitudinal displacement of the bases in one direction, while the longitudinal taper of the reccess prevents displacement of the bases in an opposite direction, and means for disengaging the lateral portions of the spring members from the teeth. Two claims.

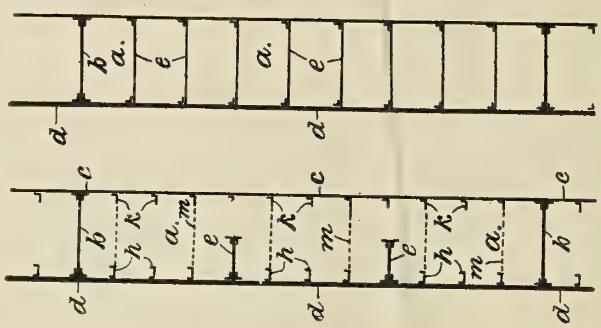
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

25487/1912. INDICATING THE SPEED OF A VESSEL IRRESPECTIVE OF A TIDE OR CURRENT. A. G. NOBLE, F. R. G. S., OF 11 BRUNSWICK STREET, LIVERPOOL.

Claim.—Relates to means for quickly ascertaining the speed of a vessel, or the strength of a current in which it is floating, consisting in two fixed sighting devices, arranged parallel to each other at a considerable distance apart on the vessel, and one stationary point some distance off (or two stationary points in a line nearly parallel with the direction of the vessel, an a single fixed sight on the vessel). An electric or other chronograph and electric contacts are arranged at each sighting position for instantaneously placing a record on the chronograph the instant a sight is taken. The speed is taken afterwards at leisure by means of tables provided.

26,269/1912. IMPROVEMENTS IN SHIPS' CONSTRUCTION. T. T. JONES, OF PIERHEAD, LIVERPOOL, LANCASTER.

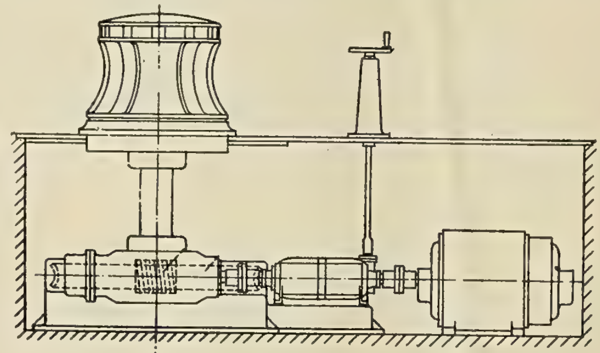
This invention consists of a modification of the metal ships' construction of Patent No. 10,405 of 1912. At the sides of the true shell of the ship is disposed within the frames and outer shell, and at or along the bottom it is on the outside of the ship; while the inner skin at the



latter part constitutes the bottom tank tops. Between vertical imperforate web-frames, as *b*, spaced at long intervals, and forming vertical watertight diaphragms between the shell plates *d* and *c*, and making the spaces between these diaphragms watertight compartments, intervening frames *e* of relatively light and of non-watertight construction, are employed, and extend from the inner shell to the outer (to which they are connected). Some of the frames, *h*, which lie midway between the web frames *e* and a diaphragm *b*, and between the web frames *c*, are, at their upper parts, connected to the frames *k* by a partition or web plate extending between them.

26376/1912. IMPROVEMENTS IN POWER-DRIVEN CAPSTANS. THE VARIABLE SPEED GEAR, LTD., AND J. ROBSON, OF BROADWAY COURT, WESTMINSTER, LONDON.

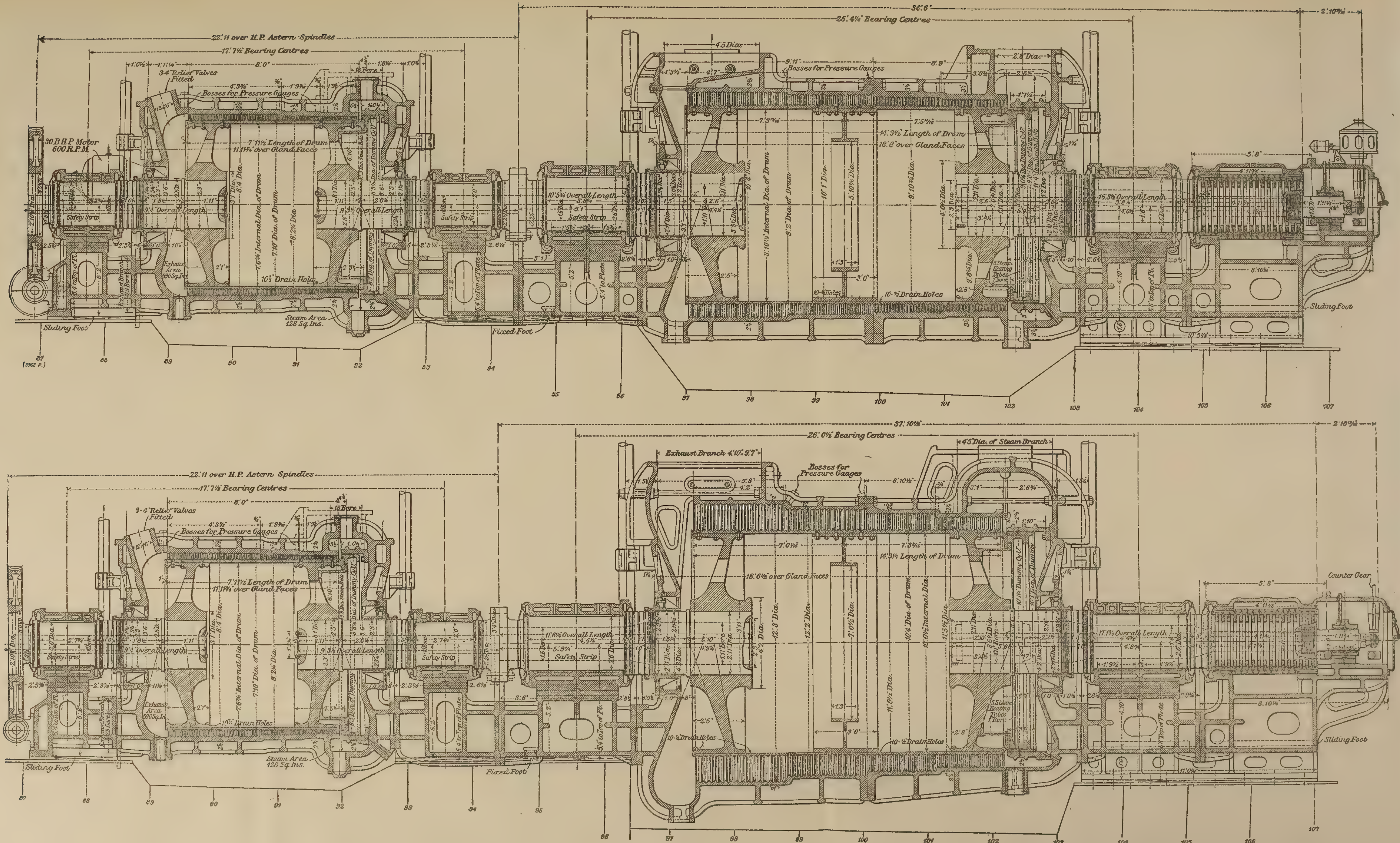
According to this invention the capstan head is actuated by a motor which is worked from a pump capable of supplying liquid to the motor at varying rates of flow, the pump and motor being preferably consti-



tuted by the pump and motor units of a variable transmission gear, which may comprise a cylinder barrel having a number of parallel cylinders for the reception of pistons provided with piston rods that are pivotally connected to the pistons and to a plate carried by a tilting box which, in the case of the pump unit, is displaceable so that the plate can be adjusted to any desired inclination with respect to the barrel in order that the direction and rate of flow of the liquid can be caried at will.

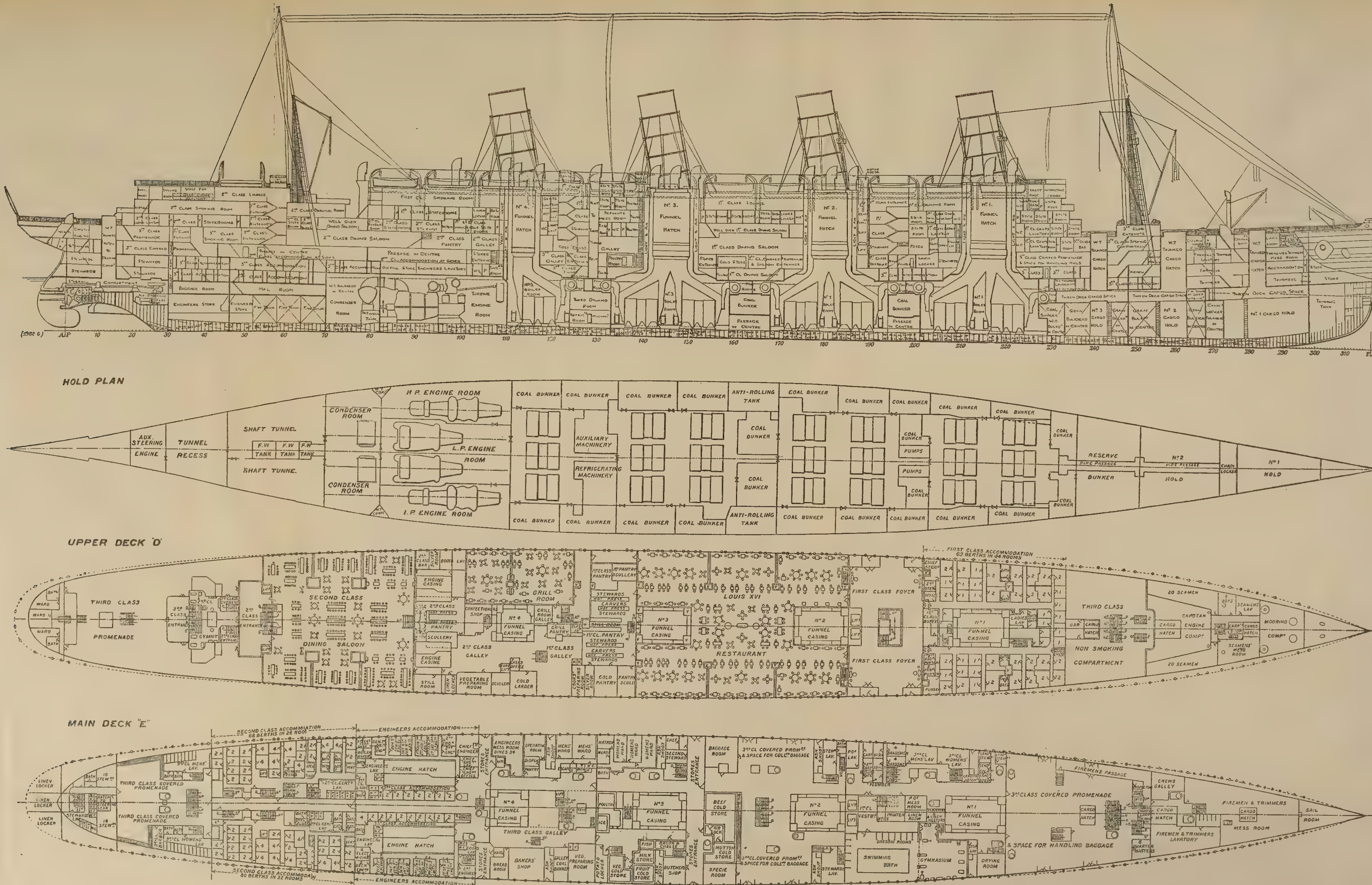
900/1913. IMPROVEMENTS IN SHIPS' BULKHEADS. T. R. OSWALD, OF "RIVERVIEW," BEACONSFIELD ROAD, BLACKHEATH, LONDON, S. E.

Claim.—The bulkheads according to this invention are reinforced by stringers attached to them and to the sides of the vessel, such stringers being widened at their ends for the purpose (and also for strengthening the sides of the vessel). The bulkheads may be further strengthened by one or more buttresses of hollow formation and are arranged on one or both sides of the bulkhead, being efficiently attached to the bulkhead as also at the head to the deck and at the foot to the tank-top on one or both sides of the bulkhead, being efficiently attached to the pumps or as passages or for ladders, etc.



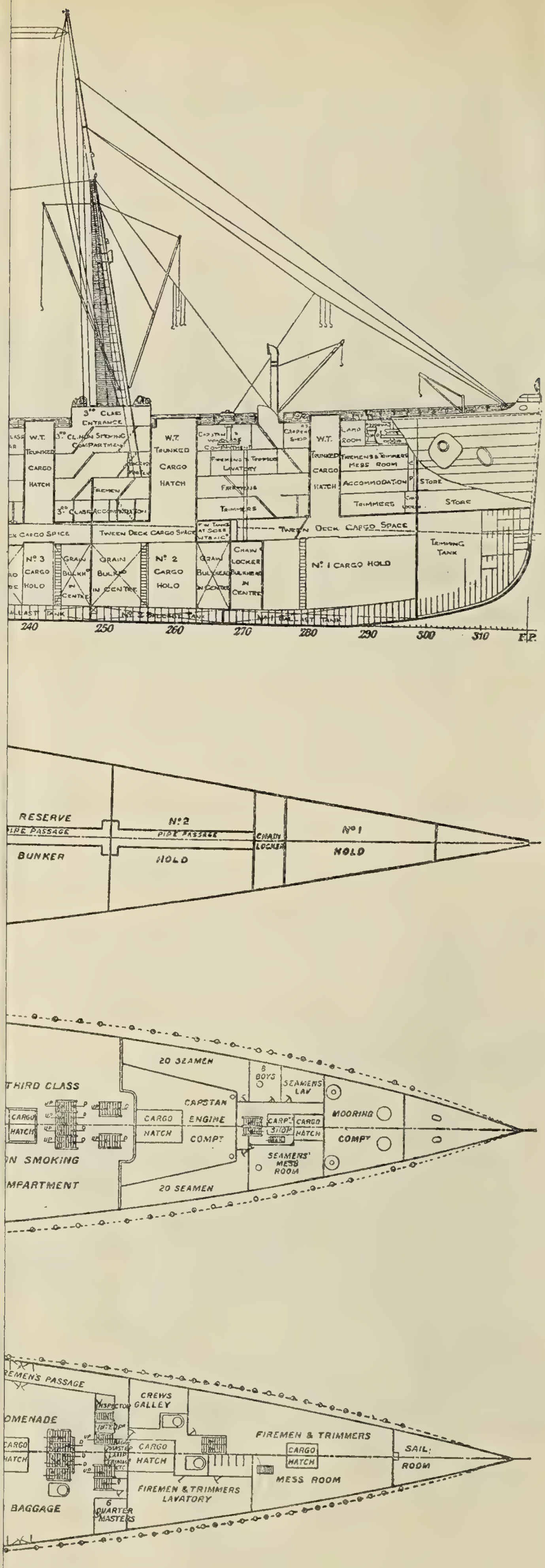
HIGH PRESSURE AND INTERMEDIATE PRESSURE AHEAD TURBINES AND HIGH PRESSURE ASTERN TURBINES OF THE *AQUITANIA*

(Reproduced from *Engineering*)



PROFILE AND DECK PLANS OF THE *AQUITANIA*

(Reproduced from *Engineering*)



3RD CLASS ENTRANCE
W.T. TRUNKED CARGO HATCH
3RD CLASS ACCOMMODATION
TWEEN DECK CARGO SPACE
No 3 CARGO HOLD
GRAIN BULKHD IN CENTRE
No 2 CARGO HOLD
CHAIN LOCKER
No 1 CARGO HOLD
TRIMMERS
ACCOMMODATION
STORE
TRIMMING TANK
240
250
260
270
280
290
300
310
F.P.
RESERVE
PIPE PASSAGE
BUNKER
No 2
PIPE PASSAGE
HOLD
CHAIN LOCKER
No 1
HOLD
THIRD CLASS
CARGO HATCH
N SMOKING
MPARTMENT
20 SEAMEN
8 BOYS
SEAMENS LAV
CAPSTAN ENGINE COMPT
CARGO HATCH
MOORING COMPT
SEAMENS' MESS ROOM
20 SEAMEN
REMEN'S PASSAGE
OMENADE
CARGO HATCH
CREWS GALLEY
FIREMEN & TRIMMERS
MESS ROOM
SAIL ROOM
FIREMEN & TRIMMERS LAVATORY
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The New Cunard Express Liner Aquitania

Decription of the Hull and Machinery of the Latest Addition to the Famous Cunard Fleet

The new Cunard Liner *Aquitania,* built by John Brown & Company, Ltd., Clydebank, arrived in New York, June 5, on her maiden voyage. The voyage from Liverpool to Ambrose Channel Lightship, a distance of 3,181 nautical miles, was made at an average speed of 23.1 knots. Surpassing the previous Cunard express steamers *Lusitania* and *Mauretania* in every particular except speed, the *Aquitania* is 901 feet long overall; 97 feet beam with a molded depth of 64 feet 6 inches. With a displacement of 49,430 tons, the vessel draws 34 feet of water, the weights being distributed approximately: Hull, 29,150 tons; machinery, 9,000 tons; bunker capacity, 6,000 tons; total deadweight capacity, 11,280 tons. According to approximate measurements, the gross tonnage is 46,150 and the net tonnage, 17,500. Accommodations are provided for 618 first class, 614 second class, and 1,998 third class passengers, making a total of 3,230 passengers, which, with a crew of 972, brings the total number of persons provided for on board the ship up to 4,202.

Every important detail of this magnificent ship is fully described in a comprehensive and fully illustrated article published in ENGINEERING, May 8, 15, 22 and 29, to which we are indebted for many of the machinery details given below and for the drawings reproduced herewith.

Hull Construction

From bow to stern there is a double bottom, which has a depth of 5 feet 4 inches, increased to 6 feet 3 inches in the turbine room. In all there are 41 watertight compartments in

Fig. 1.—New Cunard Liner *Aquitania*, Built by John Brown & Co., Ltd., Clydebank

the double bottom, each of which can be pumped out or filled separately. Five of the fore-and-aft girders are watertight and there are further six longitudinal intercostal girders, composed of 12/20 inch plates. The center keelson is built up of 21/20 inch plates, with double angles at top and bottom, secured to a flat keel made up of three plates of a collective thickness of 3½ inches. The seven longitudinals on each side of this center girder are 12/20 inch thick.

The frames above the margin plates are steel channels. Web frames, 36 inches deep, are introduced at every third frame throughout the greater part of the length of the ship, but closer where required, notably in the machinery space. All these extend at least to the deck 10 feet above the load waterline, and some to decks above this level.

The shell plating is 23/20 inch thick amidships, the sheer strakes being doubled and riveted by hydraulic riveters.

The hull is divided into eighty-four compartments, in addition to the forty-one in the double bottom. There are sixteen transverse bulkheads, most of which extend 19 feet above the load waterline, while the others extend to 9 feet above the load waterline. The turbine room is divided into three compartments by two longitudinal bulkheads. Similarly, the condensing plant aft is divided into two units by a center line bulkhead. In order that the damage by collison at the point of junction of the transverse bulkhead in the machinery space with the shell plating should not affect two compartments a V-shaped connection has been made, so that damage at that point may be localized to one compartment only. The tunnel end of the condensing room is also divided into several compartments by the fresh water tanks.

There is a fore-and-aft bulkhead on each side of the space occupied by the boilers, extending a distance of 450 feet. The longitudinal bulkheads forming the inner walls of the bunkers are 18 feet from the outer skin of the ship. The space within the inner walls, constituting the boiler rooms, is thus 60 feet wide. In the coal-bunker space again there are fitted partial transverse bulkheads dividing these bunkers into ten watertight cellular sections on each side, varying from 27 feet to 33 feet in length.

The hatches to the cargo holds are trunked and made watertight to the weather deck. The engine and boiler casings are extra well stiffened by webs and made watertight to 20 feet above the load waterline. This, in conjunction with the making of the decks watertight, will localize the volume which may, owing to accident, be flooded.

Fig. 2.—Boat Deck

Fig. 3.—Promenade Deck

Fig. 4.—Garden Lounge

Fig. 5.—First Class Dining Saloon

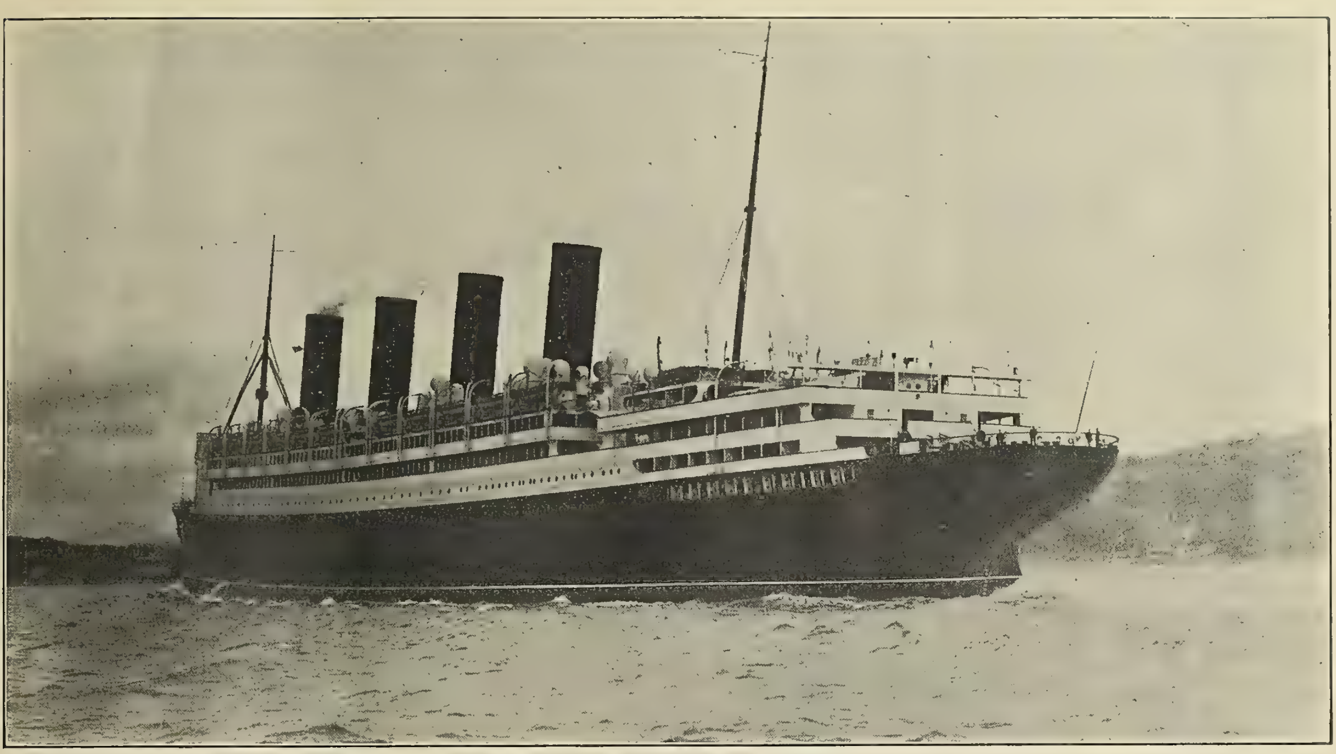


Fig. 6.—Stern View of the *Aquitania*

The main transverse bulkheads are of 12/20 inch plating stiffened by 12-inch channels space 2 feet 6 inches apart, and at intervals there are introduced vertical web stiffeners 3 feet deep, formed of 10/20 inch plates and double angles. In line with the two intercostal girders between the web frames at two points in the height of these vertical members, already mentioned, there are horizontal girders carried across the bulkheads at a level between the double bottom and "G" deck.

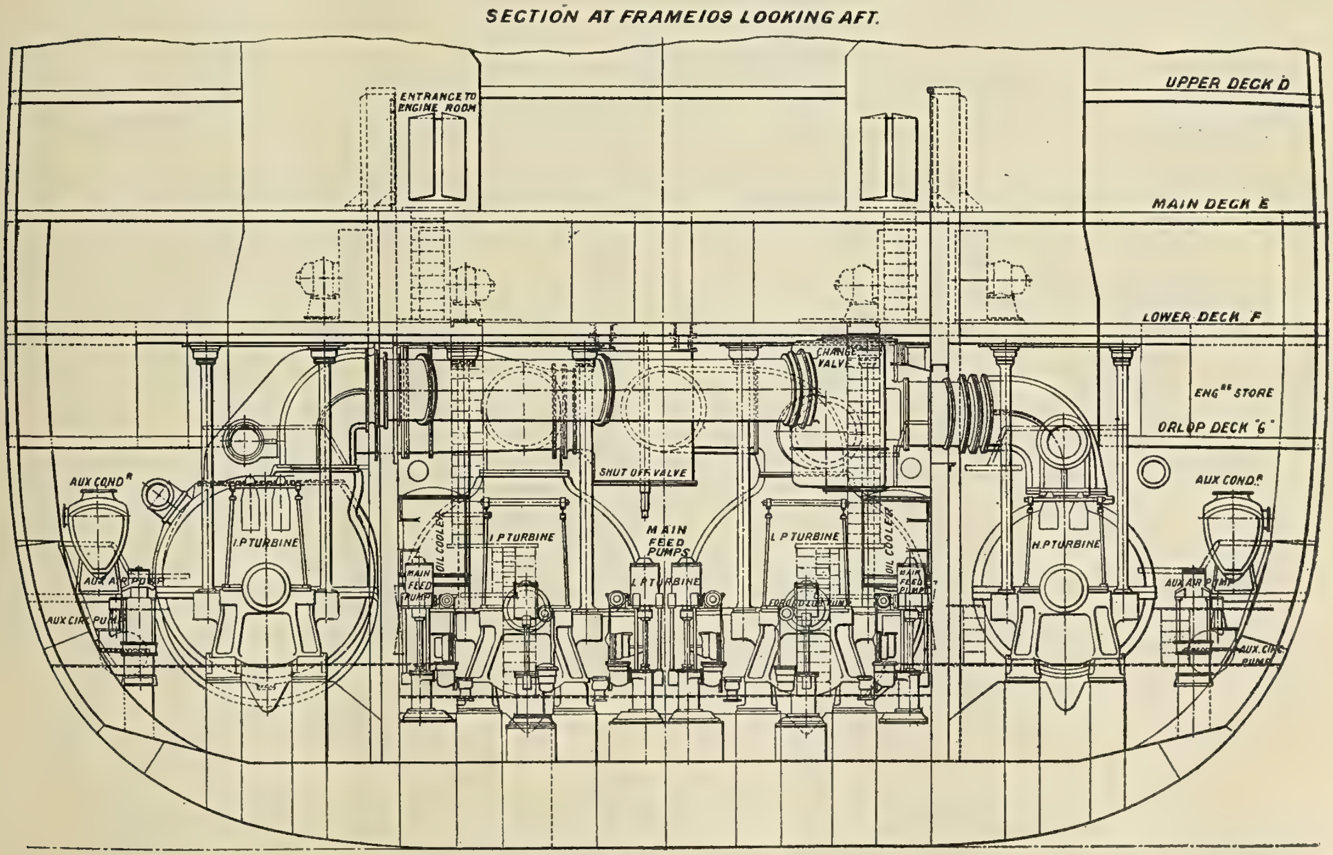


Fig. 7.—Section Through Turbine Rooms (Reproduced from *Engineering*)

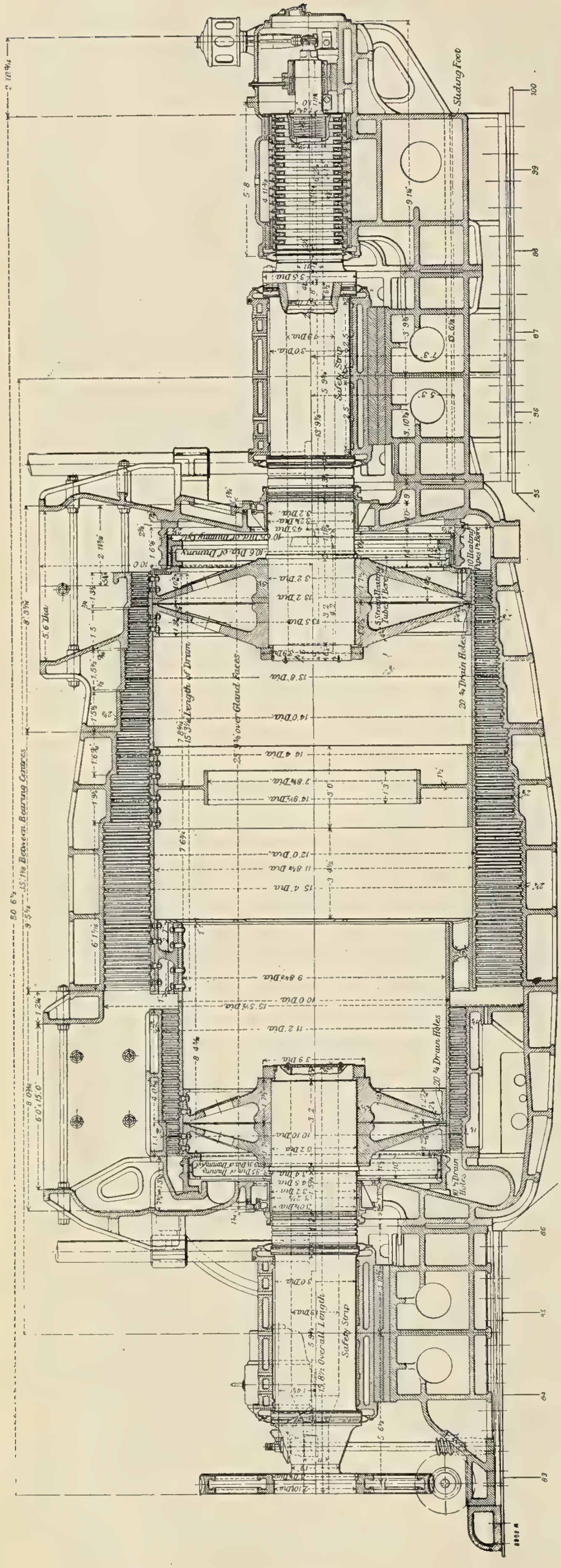


Fig. 8.—Low Pressure Ahead and Astern Turbines

(Reproduced from *Engineering*)

All the doors below and adjacent to the load line are of the sliding pattern and are fitted with Stone-Lloyd quick-closing gear.

The anti-rolling tanks take the place of one of the coal bunkers on each side of the ship.

The top strength deck, known as "B" deck, is 73 feet from the keel plate. The shell plating is doubled for a height of 12 feet at the gunwale, while the "B" deck is single plated. Below this level there are five complete decks extending fore and aft, and distant apart vertically from 8 feet to 11 feet, the greater height being on the deck where the first and second class dining saloons and some of the staterooms are located. At the ends of the ship, forward and abaft the machinery spaces, there is a partial deck, making six within the molded structure of the ship. These decks have beams at every frame, consisting of 10-inch channels. The thickness of the deck plating varies from ¾ inch to 1 inch. Special beams are fitted in the turbine compartments in order to carry the gear for raising and lowering the upper part of the casing and the rotor.

Above the molded structure of the ship there are two decks, designate the "A" deck and the boat deck. These extend 2 feet beyond each side of the molded structure, giving increased space for promenading, games and stowage of boats.

General Arrangement

There are nine decks in the *Aquitania,* in addition to the hold. Of these six are in the molded structure of the ship, while above there are three superstructure decks, the first extending for about 640 feet, the second for 624 feet, and the third, or boat deck, for about 464 feet in length amidships. Further aft, a deck house for the second class quarters is utilized for the carrying of additional boats on the same level as the boat deck proper. The total height from the keel to the boat-deck level is 94 feet.

On the boat deck accommodation is to be found at the forward end for the officers' quarters and mess room, and at the after end for men servants' mess room, as well as for the Marconi wireless telegraph office.

On the next deck, designated the "A" deck, the principal apartments arranged for are the first class drawing room, lounge, saloons, smoking room amidships, and a second class lounge further aft. The first class lounge and smoking room are connected by a long gallery. On either side of the first class lounge is a garden lounge.

On the "B" deck there are arranged many special staterooms, with one and two beds in each. The promenade extends all round the deck house, but is screened on each side at the forward end for a considerable length by extending the bulwarks up to the "A" deck, and fitting large sliding windows. In this way is formed a sheltered promenade. On the after end of the "B" deck there is the second class smoking room and drawing room, and the verandah café, outside of which there is extensive promenading space, and above which is a boat deck.

The "C" deck, which forms the top of the moded structure of the ship, is almost entirley given over to sleeping quarters. At the forward end of this deck there is space for windlasses, capstans, cargo hatches and cargo winches, and a house enclosing the entrance to the third class quarters on the decks below. The forward part of the deck affords a promenade for the third class passengers in fine weather. At the after end of the ship, also, there is space for working the ship with the necessary winches, capstans, and gear.

The first deck within the molded structure, designated the "D" deck, is given over largely to the cuisine department. In order to add to the comfort and simplify ventilation, the height between this and the deck above is 11 feet. The first class dining saloon is almost amidships, extending the full width of the ship. A foyer or reception room for the first class passengers is located forward of the first class dining

saloon. The second class dining saloon is further aft. Between the two are the galleys. At the extreme after end of this deck there is a third class smoking room and entrance to the third class quarters, while at the forward end there is a large third class social hall.

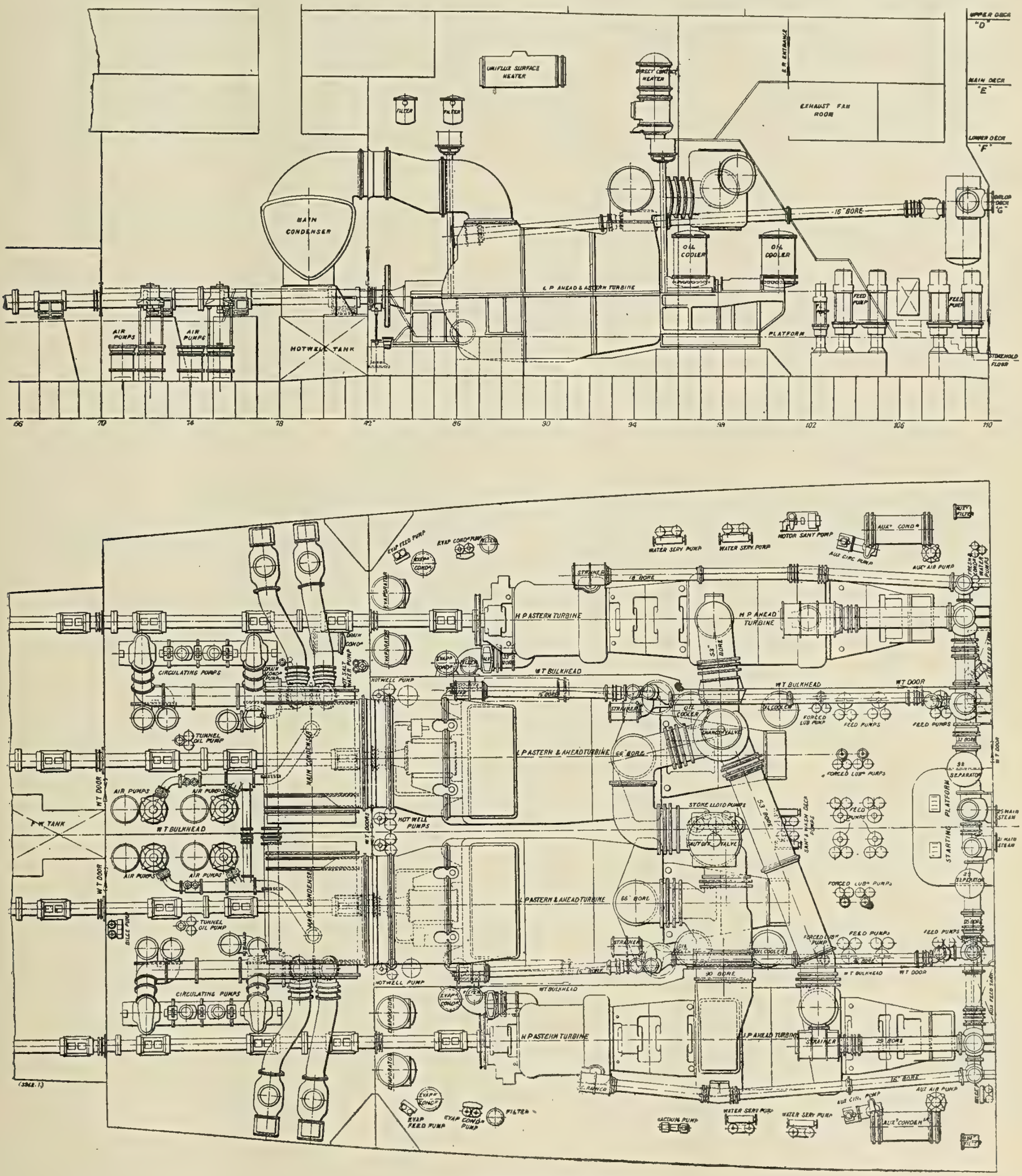


Fig. 9.—Machinery Arrangement (Reproduced from *Engineering*)

The "E" deck is regarded as the "working deck of the ship," although the first class swimming bath and gymnasium are situated on this deck. At the after end of this deck are staterooms for second class passengers and large spaces for third class promenades. There is a passage extending right fore and aft for the use of third class, or steerage, passengers.

On "F" deck are large dining saloons for the third class passengers, while the next deck, "G," is reserved entirely for third class passengers.

The seamen, firemen and trimmers are accommodated on several decks in the forecastle, while the stewards are berthed aft.

The ship has twenty-eight pairs of davits, consisting of both the swan-neck type and the Welin type, while among her boats are two motor lifeboats fitted with wireless telegraphy.

There are in all eighty lifeboats providing ample accommodation for all people on board the ship.

Interior Decorations

The restaurant in the first class accommodation measures nearly 150 feet in length and 97 feet in width; the height at the sides is 10 feet and in the center, where there is a large well 41 feet by 23 feet, the room attains a height of 19 feet; the floor area is 13,500 square feet. The decoration is in the Louis XVI style, and the woodwork is in paneled mahogany and painted grey, the whole being enriched with carved ornament and decorative paintings.

The general scheme of decoration which has been chosen for the first class lounge is that in vogue about the time of George I, and is reminiscent of the work of Sir Christopher Wren. The color scheme is wine red and vellum. The center of the room, which is 18 feet in height, is ornamented with a genuine old ceiling painting on canvas, representing an allegorical subject, and signed by Van Cuygen, a well-known decorative painter of the Dutch school. The room has large Georgian windows overlooking the garden lounge. A semicircular stage or platform is planned at one end of the room, decorated with a fine coffered vault, under which is a reproduction of the famous tapestry representing the battle of Solebay. The floor, which is of oak and suitable for dancing, is covered with a plum-colored trellis carpet, the center being a replica of a fine Savonnerie example.

The general idea in the first class smoking room has been to retain a ship effect, with architectural proportions. The plan of the room generally is interesting. It is 76 feet long and 52 feet wide, with a lofty central portion and fine spacious rooms adjoining, divided off by glaced and paneled partitions, with oak carvings of nautical trophies and draperies.

The long gallery stretches for nearly 150 feet—from the first class smoking room to the lounge. On the port side large sash windows overlook the deck promenade and the sea. The walls are paneled in mahogany and the period of decoration is about 1780, the black and grey tiling of the floor harmonizing admirably.

Stretching for a distance of nearly 150 feet on either side of the public rooms on "A" deck is the garden lounge, the surroundings of which are reminiscent of an Old English garden.

The entrance hall and main staircase, the writing rooms and the foyer or reception room, are all decorated in the Louis XVI style, while the grill room is of the early Jacobean period.

The accommodation provided for second class cabin passengers is remarkably complete, including three features which are usually only available for first class passengers—a verandah café, lounge and gymnasium. The public rooms are very large and the decoration, while less elaborate than in the first cabin, is worked out in a very tasteful manner.

Boilers

Steam is supplied at a pressure of 195 pounds per square inch by twenty-one double-ended, eight-furnace Scotch boilers, each 17 feet 8 inches mean diameter and 22 feet long. The total heating surface of all the boilers is 138,595.8 square feet and the total grate surface, 3,541.8 square feet, making a ratio of heating surface to grate area of 39.1 to 1. The shell plates are 1 19/32-inch thick, the front tube plates 25/32-inch thick and the back tube plate 13/16-inch thick over the center furnaces and 7/8-inch thick over the outer furnaces. The plain tubes are of iron 2½ inches outside diameter of 8-wire gage, while the stay tubes are from 2½-inch diameter and ¼-inch thick to 2½-inch diameter by 3/8-inch thick.

The boilers are arranged in four separate boiler rooms, six boilers are arranged three abreast in each of the three forward boiler rooms, while the after boiler room contains only three boilers. The total boiler space, including cross bunkers and auxiliary machinery rooms is 369 feet long and 60 feet wide, while the remaining space on each side from the longitudinal bulkheads to the shell of the vessel is utilized for coal bunkers. Cross bunkers are arranged between the first and second and second and third boiler rooms, while between the third and fourth boiler rooms, at the H-deck level, is the electric plant and below this an auxiliary machinery compartment.

Seven Stone's ash expellers are fitted in recesses in each boiler room. The capacity of the pumps for each expeller is approximately 4,500 tons per hour, and as these pumps can be utilized in emergency as bilge pumps their capacity adds a valuable margin of safety in case of disaster.

Howden's latest system of forced draft is applied to all the boilers. Twenty-eight electrically-driven fans, located in separate fan rooms on the G-deck level, supply the air for combustion. The fans are 66 inches diameter, designed to run at a speed of 450 revolutions per minute against a pressure of 3½ inches of water. Each pair of fans is driven by one Allen electric motor of 50 horsepower.

Propelling Machinery

Propulsion is by Parsons turbines of approximately 56,000 horsepower arranged according to the triple expansion system on four shafts. Two longitudinal bulkheads divide the engine room into three compartments—the high-pressure ahead and the high-pressure astern turbine are in the port engine room, the intermediate-pressure ahead and another high-pressure astern turbine are in the starboard engine room, while two low-pressure ahead turbines, in which are incorporated the low-pressure astern turbines, are in the center engine room, actuating the two center shafts. Aft of the turbine rooms are the two main condensers, located in separate compartments.

The high-pressure ahead turbine is 40 feet 2 inches long overall and weighs 240 tons. The high-pressure ahead rotor drum is 9 feet 2 inches diameter and weighs about 80 tons. The drum is in two portions connected by a heavy junction wheel. There are four stages of expansion in this turbine, the blades varying from 3⅝ inches to 7 inches long. The casing of the turbine is of cast iron. The high-pressure astern turbine, fitted abaft the high-pressure ahead turbine, is 22 feet 11 inches long and weighs 120 tons. There are four expansion stages, the blades varying from 1½ inches to 3 inches long, while the high-pressure astern rotor drum is 7 feet 10 inches in diameter, weighing 40 tons.

The intermediate-pressure turbine is similar to the high-pressure turbine, except for the dimensions. The ahead turbine is 41 feet 6½ inches long and has four expansion stages with the blades varying from 6¾ inches to 14 inches long; the rotor drum is 10 feet 4 inches diameter. As the astern turbine coupled with the intermediate-pressure ahead turbine is a high-pressure turbine, it is a duplicate of the high-pressure astern turbine on the port wing shaft.

The low-pressure ahead and astern turbines on the inner shafts, which are incorporated in the same casings, are 54 feet 3 inches long with rotor drums 12 and 10 feet in diameter respectively. There are nine expansion stages in the ahead turbines and four in the astern turbines. The blades in the former range from 7 to 20 inches long and in the latter from 5 to 7 inches. The ahead and astern drums are connected by a cast steel ring, while the ahead drum, which is in two sections, has a junction wheel of cast steel similar to that used in the high-pressure and intermediate-pressure turbines. Motor-driven gear is arranged for lifting the casings and rotors of the turbines, lifting motors of 30 brake horsepower operating lifting screws through worm gearing.

As shown in the machinery arrangement plans, the high-pressure turbines in the wing compartments are placed well

forward, while the low-pressure turbines are placed aft close to the main condensers. At the after end of the wing compartments are located the evaporating plant, auxiliary pumps and the auxiliary condensers. At the forward end of the center turbine room are located the main feed, sanitary and forced lubrication pumps. Forced lubrication is supplied to all the turbine bearings as well as to the tunnel shaft bearings. For the latter, six direct acting Weir pumps, 12½ by 10 by 24 inches are required, four being used to maintain the oil supply.

The two main condensers are of Weir's uniflux type, constructed by Messrs. John Brown & Company, Ltd., each having 23,000 square feet of cooling surface, circulation being on the double-flow system. The main circulating pumps supplied by Messrs W. H. Allen, Son & Company, Ltd., are four in number arranged in two pairs. The steam cylinders are 14 inches in diameter by 10½ inches stroke, each engine being capable of delivering 18,500 gallons of water per minute against a total suction and delivery head of 31 feet 6 inches, the speed being 350 revolutions per minute. Each condenser is supplied with two sets of Weir dual air pumps, the air cylinders being 38 inches diameter by 21 inches stroke, each driven by a steam cylinder 20 inches diameter by 21 inches stroke.

The exhaust from the auxiliaries and the turbo electric plant is led to auxiliary condensers at the forward end of each wing turbine room. The auxiliary condensers are of Weir's unflux type with 2,000 square feet of cooling surface each. The circulating pumps supplied by Messrs. Allen deliver 2,500 gallons of water per minute against a 20-foot head when running at a speed of 330 revolutions. The air pumps of Weir's monotype design have air cylinders 24 inches diameter and steam cylinders 12 inches diameter, both with a 15-inch stroke.

AUXILIARIES

Three pairs of Weir's standard feed pumps, supplemented by a duplicate installation of auxiliary feed pumps, are located at the forward end of the center turbine room. These pumps have water cylinders, 13 inches diameter and steam cylinders 18½ inches diameter by 27 inches stroke. Four Weir hotwell pumps, 14 inches by 12 inches by 26 inches stroke, are located in each condenser room, each pump being capable of delivering the feed water for 14,000 shaft horsepower. Four Harris feed water filters arranged in pairs on each side of the center turbine room are supplied and two Weir uniflux surface feed heaters, each with a heating surface of 1,000 square feet, capable of dealing with the feed water for 28,000 shaft horsepower. Other pumps in the central turbine room include a vertical duplex 11-inch by 10-inch by 10-inch sanitary pump, and a similar one for deck and fire purposes with a capacity of 200 tons per hour and three pumps for the Stone-Lloyd watertight door system.

Ventilation of the machinery compartments is accomplished by the plenum system, the fan equipment for which consists of nineteen motor-driven Keith-Blackman supply and exhaust fans with an aggregate capacity of 660,000 cubic feet of air per minute. The refrigerating plant, installed for the preservation of the ship's stores, is of the carbonic-anhydride type, manufactured by the Liverpool Refrigeration Company, Ltd., Liverpool. For ventilating the passenger quarters the thermo-tank system has been adopted, the installation consisting of about 100 units electrically operated.

THE ELECTRIC PLANT

Electricity is supplied by four 400 kilowatt 1,500 revolutions per minute 225-volt direct-current turbo generating sets of the British Westinghouse type, located on the G-deck, between the second and third boiler rooms, while an emergency set, consisting of a 45-brake horsepower Diesel engine, supplied by Messrs. Mirrlees, Bickerton & Day, coupled to a Westinghouse 30-kilowatt generator, is located on the promenade deck for emergency purposes. Current is supplied for about 180 motors aggregating over 2,000 horsepower, and for about 10,000 lamps.

Steamship *President* Converted into an Oil Burner by the Seattle Construction and Dry Dock Company

Steamships President and Governor Changed to Oil Burners

In view of the fact that the Pacific Coast Company, holding corporation of the Pacific Coast Steamship Company, owns and operates extensive coal mines adjacent to Seattle, the conversion of the steamships *President* and *Governor,* owned by the Pacific Coast Steamship Company, from coal to oil burners, is of peculiar significance. The alterations in these vessels were made at the plant of the Seattle Construction & Dry Dock Company, Seattle, Wash.

The steamship *Congress,* of the same fleet, built last year at the yards of the New York Shipbuilding Company, Camden, N. J., is also an oil burner. These three vessels are the speediest passenger liners of the North Pacific coast, traveling on express schedule between Seattle and San Diego, via San Francisco and San Pedro. They make a round trip every fortnight, spending three days in Seattle and two days in San Francisco each voyage. Consequently the question of discarding coal in favor of oil was a serious question, and as

the company operates its own coal mines, it was natural that the Pacific Coast should be one of the last large companies on this coast to adopt oil. More than 90 percent of the coasting steamers in North Pacific waters are now users of oil.

When the *Congress* was planned she was to be fitted as a coal burner, but during construction the plans were changed and the latest addition to the fleet was fitted with oil-burning equipment. Her fuel capacity is 7,500 barrels, giving her a steaming radius of 4,200 miles. On her maiden voyage to the Pacific via the Strait of Magellan she used oil with success, not once during the long run was it necessary to stop the engines on account of fuel troubles. The *Congress* called en route at Trinidad and Taltal to replenish her fuel supply and she arrived at San Francisco in 57 days, including stops.

The *President,* which has just returned to service, was converted at the Seattle yards on a contract working time of thirty-five days. The Dahl high-pressure mechanical system was installed, the contract including the installation of all necessary pumps, heaters, strainers, meters, gages, etc. Her capacity is 5,600 barrels, and on her maiden run following the change the fast steamer added one knot to her steaming speed. As she previously held the steaming record between San Francisco and Seattle of 47 hours and 30 minutes, she is now practically the fastest vessel engaged in coastwise traffic in North Pacific waters.

In making the oil installation, the vessel's double bottom was converted into fuel tanks to carry her capacity, while in the space formerly occupied by the forward coal bunkers was installed the big settling tank to which the oil is pumped from the double bottom tanks. The plans for the *Governor* call for practically the same work, the capacity of the latter to be 5,600 barrels also. This fuel gives each vessel a steaming radius of practically 3,150 miles. As the distance of each voyage to San Diego and return is approximately 2,623 miles, each vessel has ample surplus. On each call at San Pedro the vessels will fill their oil tanks.

Using coal, these vessels formerly filled their bunkers with about 1,350 tons upon each call at Seattle. This operation required nine working hours, which frequently meant from twelve to fifteen hours, including waste time. Now the vessels can fill their tanks while working cargo, thereby effecting a considerable saving in time, which is no insignificant item when it is recalled that these vessels are almost constantly moving and are running on a schedule almost as exacting as that of an express train.

Roughly estimating the value of coal at $3.30 (13/9) per ton and that of fuel oil at 80 cents (3/4) per barrel, it is figured that the *Governor* and *President* will effect a saving in fuel cost alone of between $800 (£164) and $1,000 (£205) per voyage. While the cost of installation is heavy, probably between $30,000 (£6,150) and $40,000 (£8,200), the economy of oil over coal will soon repay the outlay.

There are, however, other important features of oil burning which appeal to the owners. With the elimination of coal bunkers, each vessel has approximately 600 tons of additional cargo space, which is of much value considering the demand for such space, especially at certain seasons. Probably the most important economy effected, however, is that in crew. Formerly the *President* carried a total of 136 men, and now her roster is but 113. The reduction of twenty-three men is apportioned to twenty-one in the engine department and two in the steward's department, the latter being eliminated following the reduction of the fireroom force. Whereas, the engine room crew formerly numbered forty-four, there are now but twenty-three required. In addition to the saving in wages and subsistance of these men, the quarters formerly occupied by them have been turned into added cargo space. Only those who know the difficulty of obtaining competent and trustworthy seagoing men on this coast can appreciate the economy effected by this reduction in crew.

When using coal on these vessels, it was customary to clean fires with the change of watches every four hours. This resulted in a loss of steam, requiring more coal and increased revolutions to make up the difference. With oil a steady fire and steady steam pressure are maintained, enabling the express liners to make better time and resulting in lesser strain on machinery and engines.

The loss of the coal business to the steamships is not felt by the mines, for this output finds a ready demand everywhere, so that, considering the fine record already made by the *Congress* and *President,* the company is more than pleased with the change.

The *President* and *Governor,* like the *Congress,* were built at Camden by the New York Shipbuilding Company, the *President* in 1906 and the *Governor* a year later. They have been operating steadily on the Seattle-San Diego route and have done much in building up a constantly growing passenger traffic between California and Puget Sound. In addition to carrying general cargo, the speed of the fine liners makes them popular in carrying perishable goods. They have proved an immense success on this route, and, with their increased speed and greater earning capacity with oil, it is expected that they will prove more popular with the traveling public and more satisfactory to their owners.

Among other vessels recently installed with oil burners by the Seattle Construction & Dry Dock Company are the following: the steamships *Tacoma, Potlatch, Kulshan, Sol Duc, Sious, Comanche, Latouche, Stanley Dollar, Falcon, Princess Adelaide;* the tugs *Pioneer, Milwaukee;* the United States suction dredge *Colonel P. S. Michie,* and the yacht *Cyprus.*

LAUNCH OF THE ATLANTIC.—The steamship *Atlantic,* one of two sister ships now under construction at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., for the Emory Steamship Company, of Boston, was launched May 26. The *Atlantic* is a single-screw vessel of the single-deck type, 405 feet 9 inches long over all, 388 feet long between perpendiculars, with a molded beam of 54 feet 4 inches and a molded depth of 31 feet 8 inches. The cargo space is subdivided by transverse watertight bulkheads into three cargo holds of exceptionally large size, adapted for carrying lumber or bulk cargo, such as coal, grain, etc. Arrangements are also made for carrying a large deck cargo of lumber. Propulsion is by a triple-expansion engine, with cylinders 25, 41 and 68 inches diameter and 48 inches stroke, supplied with steam at 190 pounds pressure from three single-ended coal-burning Scotch boilers, 13 feet 9 inches diameter and 11 feet 10 inches long, working under heated forced draft on the closed ash-pit system. The auxiliaries include a 25-ton evaporator, a 1-ton refrigerating machine, a 15-kilowatt General Electric marine generating set and nine Lidgerwood cargo-handling winches. The vessel has a straight stem, a semi-elliptical stern and a single steel upper deck with a full poop, a bridge house amidships and a top gallant forecastle.

NEW DESTROYERS FOR THE TURKISH NAVY.—The Chantiers et Ateliers Augustin Normand, of Havre, France, has received an order from the Turkish Government for twelve torpedo boat destroyers, of which six are to be built at once, and the other six within three years. The destroyers are 287 feet long between perpendiculars with a displacement of 1,040 tons. Propulsion is by Parsons turbines of 22,000 horsepower, supplied with steam from four Normand boilers having a total heating surface of 25,824 square feet. According to specifications, the vessels must average a speed of 32 knots on a six-hour trial. The armament consists of five 4-inch guns and six 21-inch torpedo tubes.

The Submarine Tender Fulton

Description of the First Submarine Tender Built for the United States Navy—Diesel Engines Installed

There is now nearing completion at the works of the Fore River Shipbuilding Corporation at Quincy, Massachusetts, the first submarine tender for the United States Navy. This vessel, named the *Fulton*, is from the designs of the New London Ship and Engine Company, of Groton, Connecticut, by whom her engines were also designed and built. She is of interest, not only as being the first of a new type of vessel, but also as being the first large vessel for the Navy equipped with Diesel engines.

The *Fulton* was launched June 6 and christened by Mrs. Alice Crary Sutcliffe, the great-grand-daughter of Robert Fulton, for whom the vessel is named. Unlike most naval ships, the *Fulton* was built to merchant specifications, and when in service will be the mother ship for a division of submarines.

The principal dimensions of the vessel are as follows:

Length over all	226 feet 6 inches
Beam	35 feet
Draft, load	12 feet 11½ inches

The crew consists of about 190 officers and men.

The object of the design has been to furnish a vessel for an auxiliary to submarines, which may accompany them and carry necessary fuel, stores and ammunition, and which may, at the same time, be able to perform routine repairs to their machinery and outfit, and to charge their air flasks, storage batteries and fuel tanks. For this reason the military features of the design have received minor attention, and all possible weight and space have been devoted to storerooms, oil tanks, and machine shops. As it is necessary for the tender to carry fuel oil for the submarines, it is desirable that she also use the same fuel for propulsion, in order to obviate the necessity of storing two kinds of fuel—oil and coal. This object might, of course, have been attained by using either a steam plant with oil-burning boilers or oil engines. The latter were chosen on account of their much greater fuel economy, which gives greatly increased carrying power with the same radius of action. The space required for propelling machinery is also materially reduced.

General Arrangement

The vessel is of the flush-deck type, with two principal decks—the upper deck and berth deck, and with partial platform decks at the ends. Upon the deck is a deck house. There are two pole masts with derrick booms.

The hold contains the chain locker, storerooms, warhead and ammunition magazines and fuel tanks. The main engines and auxiliary boiler room are located amidships. On the platform deck are storerooms and torpedo magazines forward, and crew's space aft. On the berth deck are crew's quarters and petty officers' quarters aft, machine shop amidships, and torpedo testing room and wardroom quarters forward. In the deck house are located the commander's cabin, offices, galleys, and sick bay. A pilot house is located over the forward end of the deck house.

It will be seen that the distinguishing feature of the hull arrangement is the provision of ample stowage space, magazines, crew space, a machine shop, and a torpedo testing room. The storerooms are divided into two groups, those for the tender's stores, and those for submarine spares and stores. The fuel oil, carried in the double bottom space and in a transverse tank in the hold, is sufficient for the vessel's own use, and for supplying a division of submarines. The crew's quarters furnish accommodations for submarine crews as well as for the necessary crew for the tender.

Fig. 1.—Outboard Profile of the Diesel-Engined Submarine Tender *Fulton*

The torpedo testing room, located on the berth deck, is so placed that torpedoes can be passed from it directly to the torpedo magazine. The warhead magazine in turn is immediately under the torpedo magazine, so that the warheads may be hoisted directly from it to the latter. The machine shop lies immediately abaft and to the port side of the torpedo testing room, about the engine hatch. This grouping of the torpedo rooms and machine shop together facilitates tests and repairs. The machine shop is equipped with lathes, shapers, drill presses, milling machines, and the other necessary machine tools for repairs to the engines and auxiliaries of the submarines.

The sick bay is of large size, with separate bath, dispensary and laboratory, in order that it may care for sick or injured from both the submarines and the tender. It is located in the deck house, in a light and airy position.

As the main engines are of the internal combustion type, it was desirable to stall an auxiliary boiler for supplying steam to the heating system, and for driving such auxiliaries as the anchor windlass, the steering engine, towing machine, and the evaporator plant, which cannot well be driven by electricity. The boiler room is located in the hold, forward of the engine room, and besides the boiler, contains feed pumps, distiller circulating pumps, sanitary pumps, air pumps, all of which

are steam-driven, condenser, feed water heater, evaporator and distiller. The boiler is equipped to burn fuel oil. This steam plant, being merely an auxiliary, is of comparatively small capacity, and creates only a comparatively small drain on the fuel supply, especially as it need be run at full power only under exceptional cases.

Propelling Machinery

On account of its novelty probably the most interesting feature of the vessel is the main propelling machinery. This consists of a single vertical, inverted, two-cycle, single-acting air-starting and reversing oil engine of the Diesel type, with six working cylinders and two air compressors. The shaft horsepower delivered is about 1,000 at about 260 revolutions.

Fig. 2, which shows the engine on the test stand, gives a general idea of the arrangement. The six working cylinders and two air compressors are on the same fore and aft line, the air compressors being at the forward end of the engine, where is located the control station. The engine is entirely controlled, starting, stopping, changing speed, and reversing, through a hand wheel at this station. The pistons are of the stepped type, the upper part forming the working piston, and the lower the scavenging piston. From the scavenging cylinder the scavenging air at low pressure is carried to an external receiver, whence it goes to the working cylinders, and overboard through the exhaust. This arrangement of scavenging cylinders has the advantage that any leakage of gases from the working cylinder, due to leaky piston rings, passes into the scavenging air, with no possibility of escaping into the engine room. In addition the crank pit is entirely enclosed. In larger engines now under construction it has been found desirable to use an open crank case form of construction, but for engines of this speed with forced lubrication, the closed crankcase has advantages, and as large, quickly-removable crankcase covers are provided, which may be removed while the engine is in motion, it is free from the disadvantage of inaccessibility.

Each working cylinder is provided with two scavenger valves, an air-starting valve, a spray valve and a relief valve. The spray valve atomizes and injects the fuel into the cylinder by means of high pressure air from the air compressors.

The scavenger valve is connected to the scavenger air receiver. All valves are driven from a cam shaft carried in bearings on top of the cylinder heads. This cam shaft is driven from the crankshaft through a vertical shaft and spiral gears. A special feature is a pneumatic cylinder which, when reversing, automatically places the cam shaft in the proper position relative to crankshaft, before air is admitted to the cylinders for starting the engine.

The wrist pins are of large size, giving very moderate bearing pressures, and located in the scavenger piston, where the temperatures are low. The scavenger cylinder acts as a crosshead guide, and is watercooled. A novel feature is the use of fresh water for cooling the pistons. Water is carried to the pistons through pipes with swinging joints, so that a continuous circulation of fresh, cool water is insured. The lubrication is of the pressure type, lubricating oil being supplied by a small lubricating oil pump. The cylinders and cylinder heads are water-cooled by a salt water system independent of the fresh water system above mentioned.

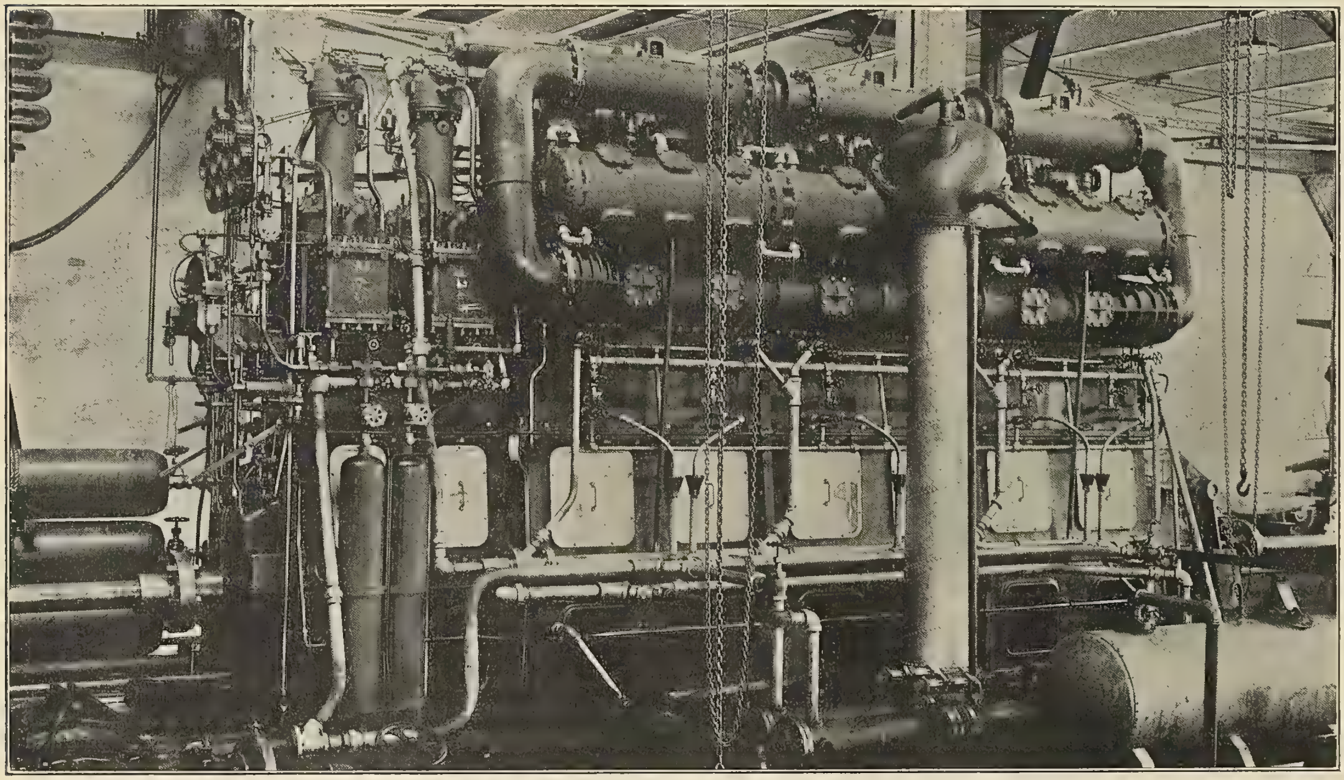


Fig. 2.—The *Fulton's* 1,000-Horsepower Diesel Engine on the Test Stand

Air Compressors

The air compressors are two-stage, and supply air for spraying the fuel and for charging the starting flasks. The cylinders and heads are water-jacketed, and the air is passed through cooling coils after the first and second stages. The air flasks are also connected to the independent ship's high pressure air line, so that air may be drawn from the latter in emergency.

The pumps form two independent motor-driven units. Each unit consists of a centrifugal salt water pump, a rotary fresh water pump, a rotary lubricating oil pump, and a rotary fuel oil pump. One unit is sufficient for the engine at full power; the other being a stand-by. The rotary fuel pump takes suction from the oil storage tanks, and discharges to a gravity feed tank in the engine hatch, whence the fuel flows to the

measuring pumps on the engine. These pumps discharge the oil in the proper measured qnantities for the power desired. A direct driven governor positively controls the quantity of oil discharged by the measuring pumps, and hence the power delivered.

The electric plant is of considerable size, as the tender is designed to be capable of charging the batteries of submarines, in addition to supplying its own electrical needs. There are two generators, driven from the forward end of the main engine crankshaft. A small turbo-driven generator is installed for lighting the ship. There are also two motor-driven air compressors of sufficient capacity to charge torpedoes or the air flasks of the submarines. A small low-pressure air compressor is installed for supplying air to pneumatic tools.

Taken all in all, it appears that this vessel promises to be a very useful accessory to our submarine flotilla. It will be a step towards the elimination of the makeshift mother ships for submarines, the use of which has been rendered necessary by the lack of vessels especially designed for such service.

The Empress of Ireland Disaster

Through collision with the collier *Storstad,* a few miles above Father Point in the St. Lawrence River early in the morning of May 28, the Canadian Pacific liner *Empress of Ireland* was sunk with the loss of nearly 1,000 lives. The ill-fated ship was rammed by the *Storstad* nearly amidships and immediately took a heavy list. Within less than a quarter of an hour the ship had sunk.

Conflicting testimony by the captains of the two vessels at present leaves the exact circumstances regarding the disaster in doubt. The two vessels had sighted each other when about two miles apart, but were afterwards enveloped in fog. Capt. Kendall, of the *Empress of Ireland,* says that the engines of his vessel were going astern, and that the vessel was without headway at the time of the collision, while Capt. Anderson, of the *Storstad,* claims that the *Empress of Island* was moving ahead rapidly, and that it was impossible for him to keep the bow of his vessel against the ship to "plug" the hole made by the impact. Fortunately the wreck of the *Empress of Ireland* lies in comparatively shallow water, so that investigation by divers is possible in order to determine the extent and nature of the damage to the hull. The extent of the damage to the bow of the *Storstad* is shown in Fig. 2.

The *Empress of Ireland* was built by the Fairfield Shipbuilding & Engineering Company, Ltd., Glasgow, in 1906. Her dimensions were: Length over all, 570 feet; beam, molded, 65 feet 6 inches; depth to upper deck, 40 feet; displacement, 20,000 tons, and load draft, 28 feet. Her propelling machinery consisted of two sets of quadruple expansion engines, each of which, running at 80 revolutions per minute, indicated over 9,000 horsepower. Steam was supplied at a pressure of 220 pounds per square inch by six double and three single-ended

Fig. 2.—Damaged Bow of the *Storstad*

Scotch boilers, placed in two boiler rooms with a large coal bunker between them. The subdivision of the hull was by nine watertight bulkheads extending to the level of the upper deck, together with a cellular double bottom.

The dangers of navigation in fog have been further emphasized during the last few weeks by several other collisions involving large passenger vessels, although none has resulted in the loss of life. On the morning of May 22 the Lake freighter *W. H. Gilbert,* loaded with, coal, bound from Toledo to Green Bay, Wis., collided with the steamer *Caldera* in fog a few miles from Thunder Bay Island, Lake Huron. The *Caldera* rammed the *W. H. Gilbert* amidships, nearly cutting her in two, so that within five minutes she had sunk. On the Atlantic the Hamburg-American liner *Pretoria* collided with the American Liner *New York* on June 13 off the coast of Massachusetts, tearing a large hole in the port bow of the *New York* above the waterline, but sustaining only slight damage herself. Four days later the German grain carrier *Incemore* collided with the North German Lloyd steamship *Kaiser Wilhelm II,* which had left Southampton a few hours before bound for New York. The *Kaiser Wilhelm II* was struck on the starboard bow and sustained damage below the waterline, while the bow of the *Incemore* was badly crumpled.

Fig. 1.—The *Empress of Ireland,* lost through collision with the *Storstad* on the St. Lawrence River, May 28

New Steamship Piers at Boston

In an article on "The Development of the Port of Boston" by Robert E. Barrett, designing engineer, Directors of the Port of Boston, in a recent issue of *Engineering News*, a comprehensive outline is given of the work already done and now in prospect for the development of steamship piers and other shipping facilities in Boston.

In 1911 the Commonwealth of Massachusetts created an independent board, known as the Directors of the Port of Boston, and made an initial appropriation of $9,000,000 (£1,840,000) for meeting the future needs of maritime commerce at this port. The expenditure of practically all of this sum has now been authorized for the construction and equipment of piers and for the construction of a drydock 1,200 feet long overall and 120 feet wide at the bottom, with a depth of 35 feet of water over the entrance sill at mean low water.

The work of pier construction is being carried out on property acquired by the Commonwealth in South Boston and East Boston. In South Boston, where five piers owned or leased by the New York, New Haven & Hartford railroad have been in use for some time, attention was directed by the Directors to Pier No. 5, which is 1,200 feet long and 400 feet wide, with the docks dredged to a depth of 35 feet of water at mean low water. By an agreement with the New York, New Haven & Hartford railroad possession of this pier was obtained by the Directors and $3,000,000 (£615,000) were allotted to its development, the proposed improvements to include dredging the berths and approaches to a depth of 40 feet at mean low water; covering the entire pier with two-story fireproof sheds supplied with best of facilities for handling both freight and passengers; laying railroad tracks on the pier; providing necessary highway connections, including a steel viaduct for passenger traffic from the second story of the pier to Summer street, by which the city proper is reached by a street clear of railroad grade crossing—a distance of 1200 feet.

The pier structure (Fig. 3) consists of three sheds connected together with light wells 20 feet wide between them. All floors are to be used for freight except the second floor of the middle shed, which is to be fitted for the accommodation of passengers. For 100 feet at the shore end a headhouse, architecturally treated with artificial stone, is being erected. This headhouse will contain offices, passenger accommodations and a carriage concourse on the second floor connecting with the viaduct to Summer street.

The pier has been designed for the use of one steamship company on each side of the pier, the passenger accommodations covering an area of about 130,000 square feet, being located on the second floor of the middle shed.

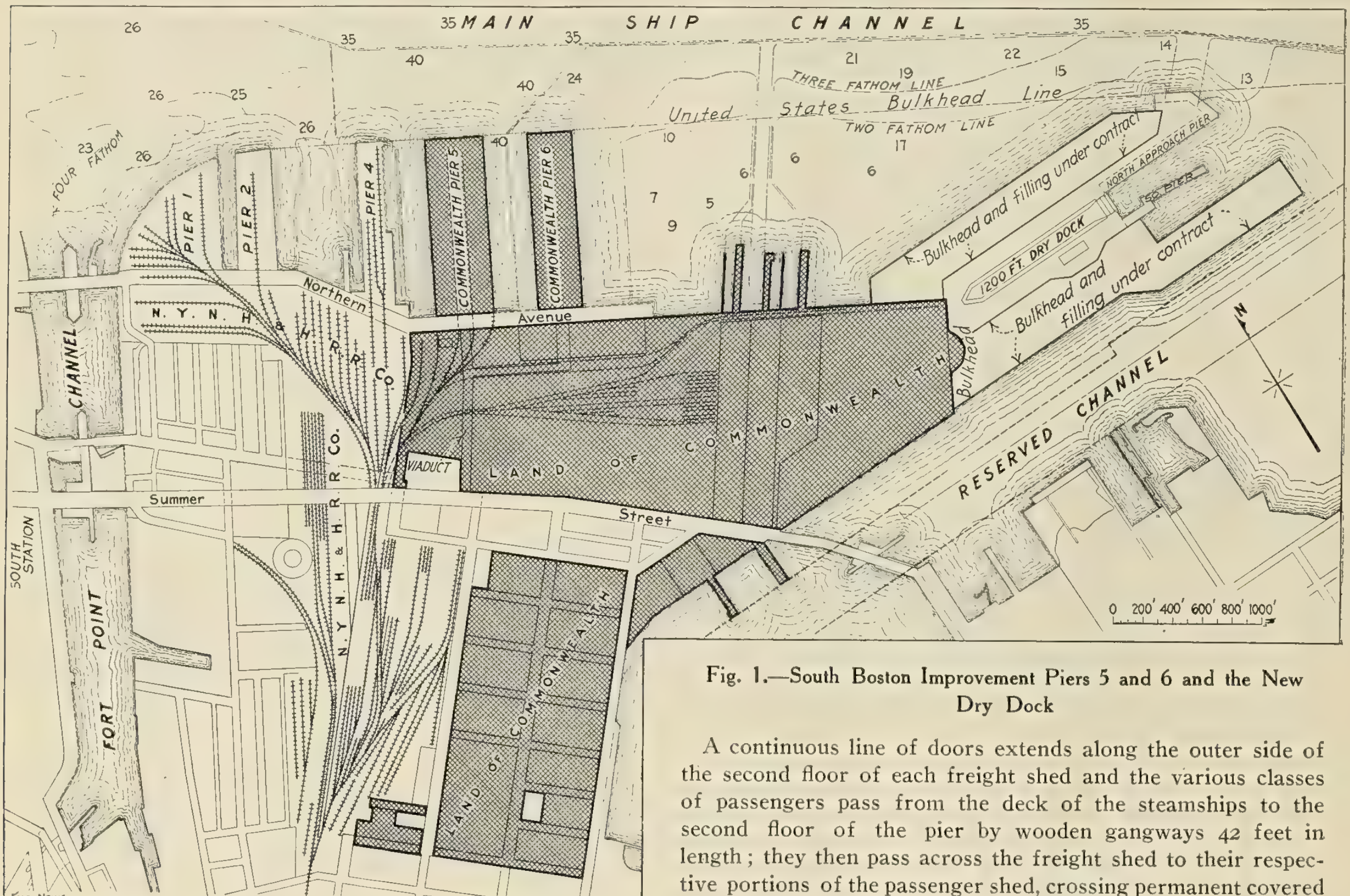


Fig. 1.—South Boston Improvement Piers 5 and 6 and the New Dry Dock

A continuous line of doors extends along the outer side of the second floor of each freight shed and the various classes of passengers pass from the deck of the steamships to the second floor of the pier by wooden gangways 42 feet in length; they then pass across the freight shed to their respective portions of the passenger shed, crossing permanent covered bridges at the light wells between the sheds. First and second class accommodations are located at the land end of the pier and emigrant accommodations are located at the harbor end of the pier, considerable space being occupied by the examination lines, detention room, hearing rooms, doctor's room and room for the use of the charitable societies. Baggage rooms and offices are located at the end of the pier adjacent to the headhouse. Steamship and railway ticket offices and an office for U. S. Customs officials are centrally located.

Between the examination rooms and the street are waiting and baggage rooms and the carriage concourse connecting with the viaduct to the city. At the sides of the concourse are the offices of the railway and steamship companies and the directors. The steel viaduct, 1,200 feet long, extends from the pier to Summer street, spans the railway tracks entering the pier on the first floor and the State storage yard for cars, and connects the pier with Boston proper by means of Summer street, and also entirely separates passenger and freight traffic.

Immigrants reach trains on the first floor by means of the

Fig. 2.—Docking of Hamburg-American Liner at Partially Completed Pier No. 5

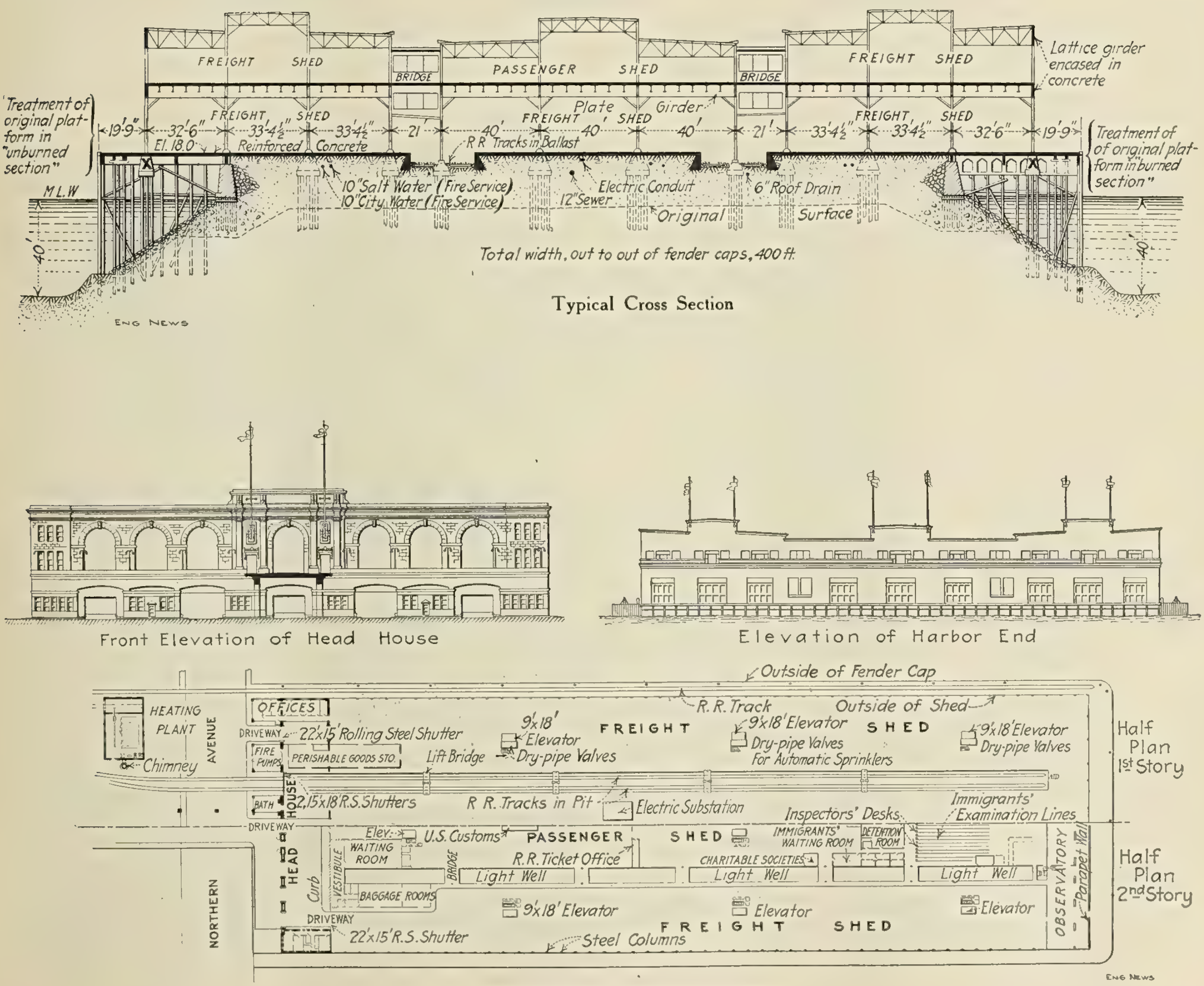


Fig. 3.—Details of Commonwealth Pier No. 5

steel stairs and suitable elevators connecting the two floors.

The second floor of the three sheds extends 20 feet farther toward the end of the pier than the roof, thus forming a balcony 20 feet wide and the entire width of the pier at the harbor end. This balcony is surrounded by a heavy masonry parapet and forms a place where friends and relatives of passengers may watch the incoming and outgoing steamers with safety and comfort.

The pier is provided with railway tracks sunk below the level of the floors so as to allow direct trucking into the cars. There is also a track on each platform outside the sheds. These tracks have direct connection with lines of the New York, New Haven & Hartford Railroad and the freight yard of that company located just southwest of the pier. By this means, freight and passengers can be landed directly at the vessel, a condition that is impossible in New York at present.

The entire lower portion of the pier and the second floor of the two outer sheds are to be used for freight, the total area devoted to freight being 500,000 square feet. Freight may reach the pier by trucks from Northern avenue or by any of the six standard railway tracks which cross the avenue at grade. A track pit is provided for two tracks on either side of the middle shed, the tracks being below the first-floor grade sufficiently to bring the car and pier floors at practically the same level. A track on reinforced-concrete rail beams is provided on the platforms at either edge of the pier, these tracks being at the level of the floor of the pier.

In addition to the train entrances, there is a driveway entrance from Northern avenue to the center of each of the three sheds for use of teams and auto trucks. Eight elevators with platforms 9 feet wide and 18 feet long and headroom of 10 feet, capable of lifting 12 tons at a speed of at least 25 feet per minute from the lower to the second floor of the pier, are provided for the interchange of freight and hoisting of trucks in the freight sheds.

At the present time, freight on the pier is generally handled by means of hand trucks. Cargo is drawn aboard and lowered into the hold by the ship's winches aided by timber slides and stages. Twenty-six portable electric winches are being provided for use in handling freight. Electric outlets have been placed at frequent intervals along the outer sides of the freight sheds in order that the winches may be used at any point.

For moving of freight across the track pits, lifting bridges have been provided. These bridges are supported on a concrete pier between tracks and two leaves are so designed as to hoist into a vertical position between tracks to allow the trains to pass.

Commonwealth Pier No. 6, 1,200 feet long and 300 feet wide, which is on Commonwealth property adjacent to Pier No. 5, has been deeded to the Boston Fish Market Corporation, which is erecting upon it suitable buildings for stores and warehouses for the various firms in the fish business. This pier provides adequate dock berths for the fleet of fishing vessels trading with the port of Boston.

In 1913 the directors of the port acquired property owned by the Boston & Maine Railroad, located in East Boston and known as "Eastern Pier," in order that a modern pier, to be known as Commonwealth Pier No. 1, equipped for the handling of passenger and freight business, could be constructed in its place.

Plans and specifications are being prepared for the erection of a pier of fireproof construction, about 1,000 feet in length and 175 feet in width, the superstructure to be two stories and of steel, with reinforced-concrete floors.

The first floor will be devoted to the handling of freight, access being obtained by means of two driveways at the level of the floor and by two depressed railway tracks in a track pit along the center of the pier; these tracks to connect with the existing railway system in East Boston.

Honolulu Floating Dry Dock

The Inter-Island Steam Navigation Company, of Honolulu, is a steamship corporation doing freight and passenger business between the five principal islands comprising the Hawaiian group. This group of islands constitutes the Territory of Hawaii, and is by no means an unimportant part of the United States, as its situation, almost in the center of the vast Pacific Ocean, makes it a touching point for nearly every vessel, freight and passenger, crossing the Pacific, and some idea of the size and importance of the inter-island transportation may be gathered from the fact that the Inter-Island Steam Navigation Company has a fleet of eighteen steamers engaged in handling passengers and freight between the islands.

At the time of taking over the islands by the United States Government, there was in Honolulu Harbor a Crandal marine railway designed for a capacity of 1,500 tons. For a number of years this railway answered the purpose of the Navigation Company for handling their vessels, but the continual growth of the business and the necessarily increased size of vessels made a change necessary, and it was finally decided to build a pontoon floating dry dock of ample capacity to handle the largest vessels of their present fleet, with the possibility of extension to a capacity sufficient to handle most of the vessels touching at the islands. The design of this dock was placed in the hands of Mr. William T. Donnelly, consulting engineer and naval architect, New York City.

As shown in the accompanying plan, Fig. 4, the dock as at present constructed has eight pontoons, making a length over all of 352 feet, length of wings of 300 feet, a width over all of 100 feet, and a clear width between the wings of 80 feet. It is designed to take a draft of 20 feet over 4-foot keel blocks.

When increased to a lifting power of 7,000 tons, the dock will have an overall length of 445 feet, and will be increased

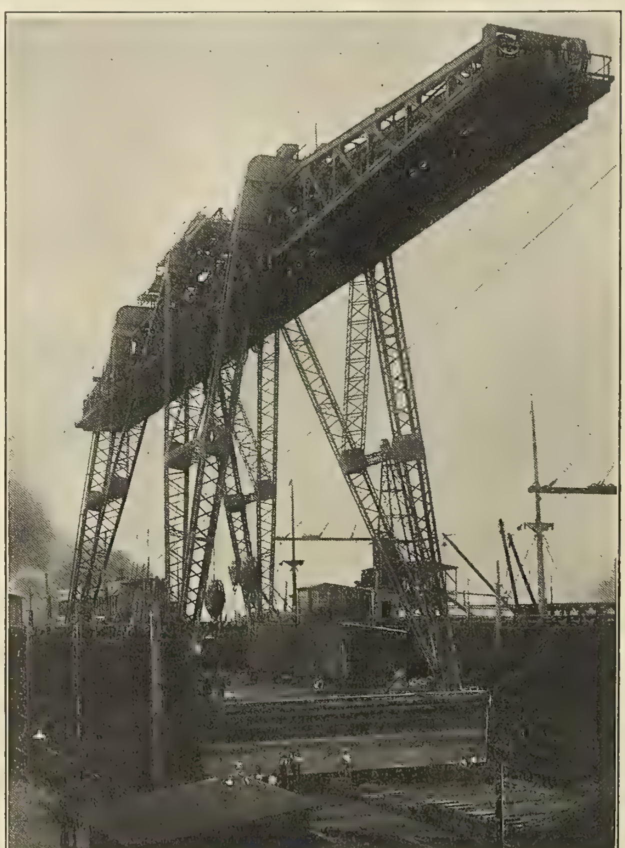


Fig. 1.—Position of Floating Derrick in Dry Dock

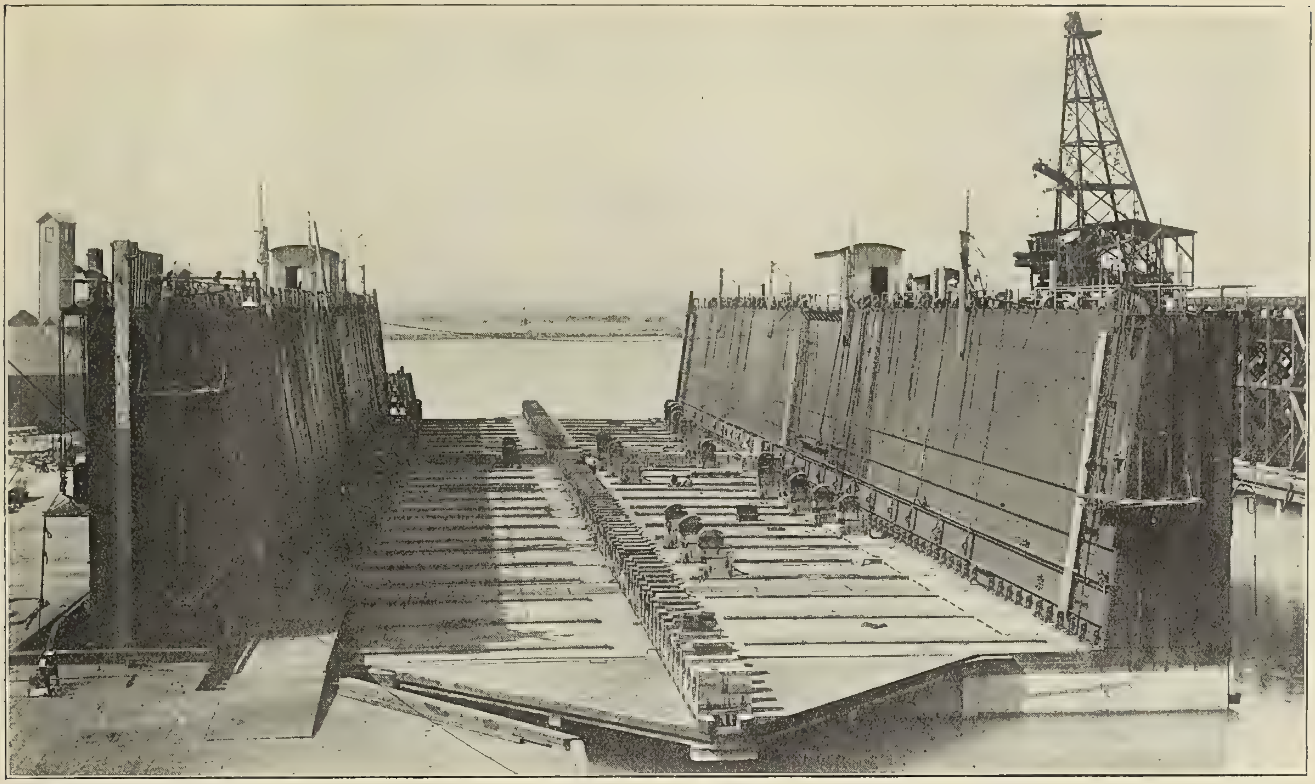


Fig. 2.—Honolulu Dry Dock Pumped Up Light

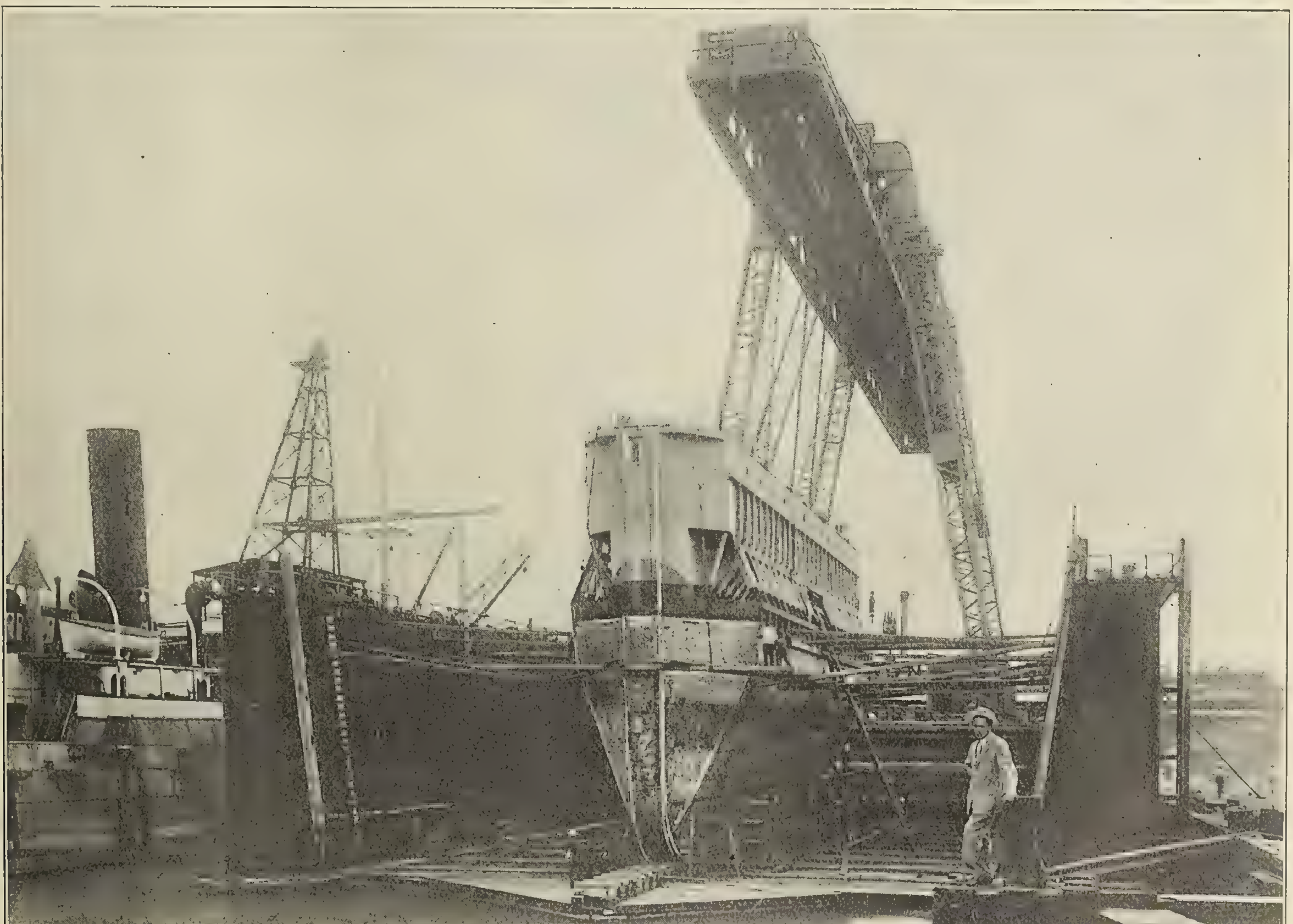


Fig. 3.—Caisson for Pearl Harbor Dry Dock and a 150-Ton Floating Crane Docked at the Same Time in the Honolulu Dry Dock

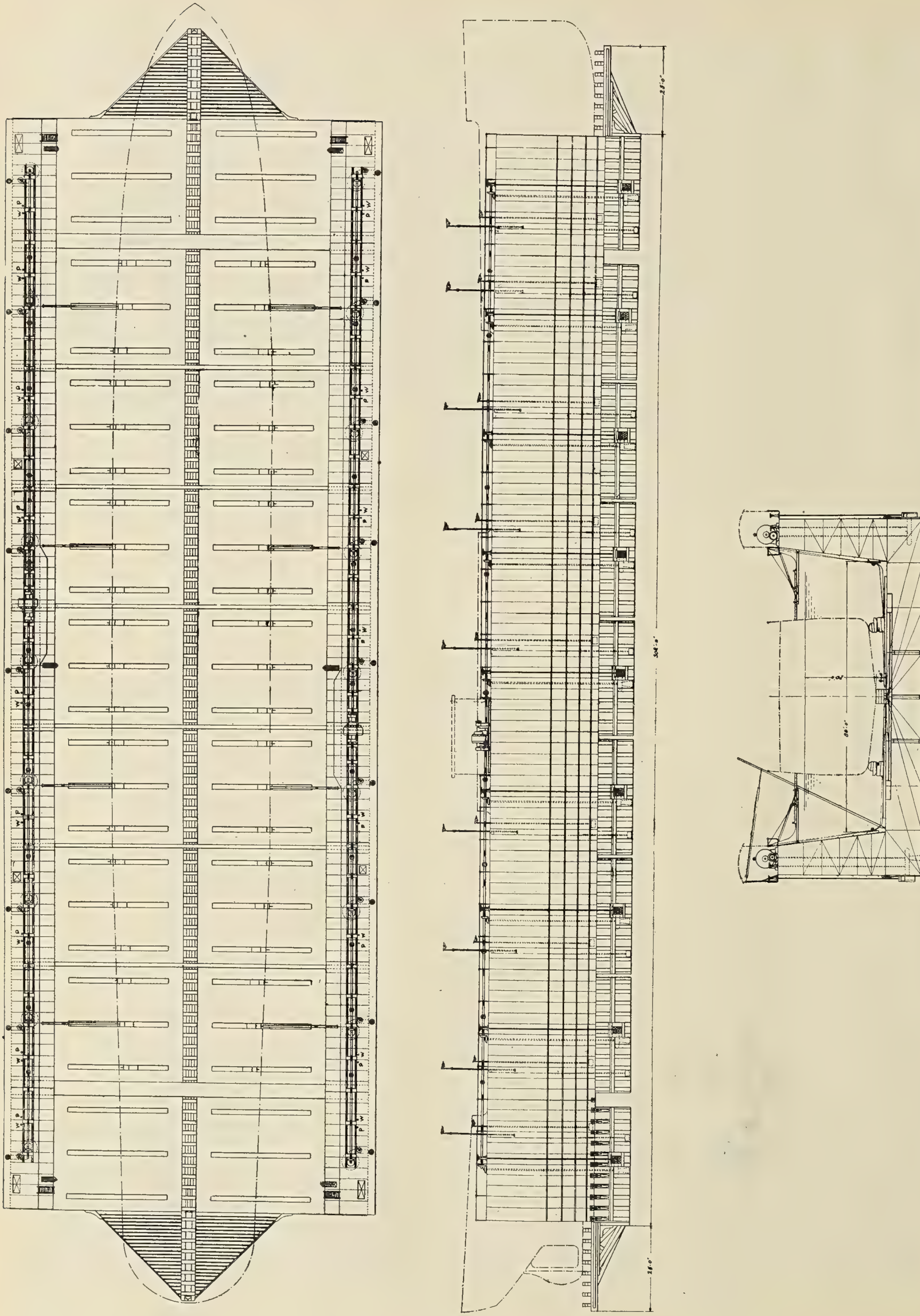


Fig. 4.—General Plans of 4,500-Ton Pontoon Floating Dry Dock, Built for the Inter-Island Steam Navigation Company, Honolulu, T. H.

in lifting power, not only by increasing its length but by substituting for the central portion of the dock deeper pontoons, thus concentrating the lifting power towards the center for heavier vessels.

The pumping machinery is operated by electricity supplied by the Hawaiian Electric Company over special duplicate feeder cables, to avoid the possibility of interruption of service. The pumping is by centrifugal pumps, there being eighteen 10-inch pumps, one in each end of each pontoon. The group of nine pumps on each side of the dock is operated by a 200-horsepower motor. These motors are controlled from a station on the pier near the shore end of the dock, so located as to be closely in touch with the dock master directing the raising of the vessel. All the machinery is of special design and made of unusual weight and strength to insure absolute reliability.

The pontoons are each 100 feet in length, corresponding to the width of the dock, 32 feet in width, corresponding to the length of the dock, and 10 feet in depth. They are built of selected Oregon pine and for protection against teredo are copper-sheathed over felt.

The steel wings are 30 feet in height, 12 feet wide at the base and 8 feet at the top, and are built continuous, connecting all the pontoons rigidly together. The attachment between the wings and pontoons is such that any pontoon can be readily detached and separated for dry docking on the rest of the dock. The steel for the wings was furnished by the United States Steel Company, fabricated in the Ambridge shops near Pittsburg, and shipped from New York by the American Hawaiian steamers.

The building of the pontoons was under the direction of Jas. A. Lyle, and the construction and equipment of the dock was carried out under the very able management of Jos. E. Sheedy, general superintendent of the company.

The dock was completed in about one year, and the first vessel raised on November 11, 1913. Since that time the dock has been constantly in use overhauling the company's vessels, and twice has raised the steamship *Wilhelmina*, of 6,974 tons register, a sufficient distance to enable a propeller blade to be replaced.

Fig. 2 shows the dry dock pumped up light. The location of the dock in Honolulu Harbor is such that it is close to the Honolulu Iron Works, which is equipped with a large machine shop and foundry facilities. Arrangements have been made between the two companies to handle ship repair business in the most rapid and economic manner.

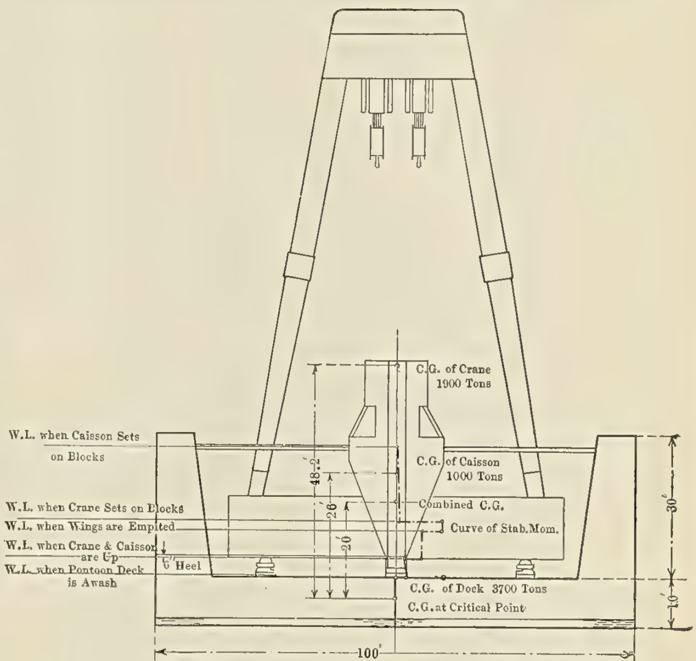
On April 9 the Inter-Island Steam Navigation Company carried out what was probably the most unique and difficult piece of dry dock work ever performed by a floating dry dock. This was dry docking at one time the United States 150-ton floating derrick and the caisson for the Pearl Harbor dry dock. These two structures are as divergent in character and proportions as it is possible to conceive. The 150-ton floating derrick has a displacement of 1,900 tons, a length of 125 feet, with a beam of 75 feet and a draft of 10 feet. The caisson is 127 feet long, 20 feet beam, and has a draft of 26 feet. The center of gravity of the floating crane is 32 feet 6 inches above the water, and the center of gravity of the caisson is necessarily much below the waterline.

As the floating dry dock was limited to a draft of 24 feet it was only possible to dry dock the caisson by partially raising it with the floating derrick, thus decreasing its draft to 23 feet 6 inches. The two structures were then floated into position in the dry dock and the dry dock pumped up sufficient to ground the caisson upon the blocks, after which it was shored in an upright position from the steel wings. The pumping was then continued and the floating derrick finally landed upon the blocking.

The confidence of the Inter-Island Company is shown from the fact that this docking was carried out between dark and midnight on account of the high tide coming about dark. Figs. 1 and 3 show this huge structure towering above the deck of the dock. The height of the top of the truss is 125 feet above the deck of the dock and its length 290 feet.

By referring to Fig. 5 there will be seen a stability diagram which was worked out before this dry docking was undertaken to show the stability of the dry dock when handling these structures. From this it will be seen that the combined metacentric height at the critical point was 10.8 feet, corresponding to 600 foot-tons righting moment.

A longitudinal view shows how the longitudinal stress can be distributed by pumping in a pontoon dry dock. From this



Stability at Critical Point 600 Ft.Tons
Metacentric Height at Critical Point 10-8 Ft.

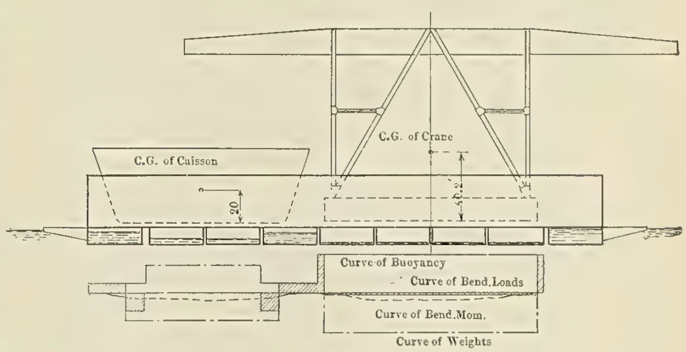


Fig. 5

it will be seen that the pontoons immediately under the weights are pumped, while those not carrying weights are left wholly or partially full of water, the result being that longitudinal stresses due to uneven loading are practically eliminated, the maximum stress in the steel wings due to loading being 0.35-ton per square inch.

When it is understood that this dry dock had been in operation only a few months and was being handled by parties previously entirely unfamiliar with floating dry docks, its great reliability will be appreciated.

LAUNCH OF THE BISMARCK.—The new Hamburg-American liner *Bismarck*, 955 feet long and 100 feet beam, a sister ship of the *Imperator* and *Vaterland*, was launched at the yards of Blohm & Voss, Hamburg, Germany, June 20.

Westinghouse Turbine Reduction Gear

Special Features of the Westinghouse Reduction Gear—Construction of the Floating Frame—Measurement of the Power Transmitted

Most of our readers are probably familiar with the general principle of the Westinghouse reduction gear, manufactured by the Westinghouse Machine Company, East Pittsburg, Pa., as the installation of this gear on the United States naval collier *Neptune* has been fully described in previous issues of this journal. Briefly the gear consists of a floating or movable frame, such as is shown at A, Fig. 4, which carries a double helical pinion in rigid bearings, the frame A having freedom, however, to adjust itself in the horizontal plane perpendicular to a plane passed through the center of the shaft and the nominal center of the pinion and thereby permitting the pinion to assume a natural deflection in accordance with the load being transmitted.

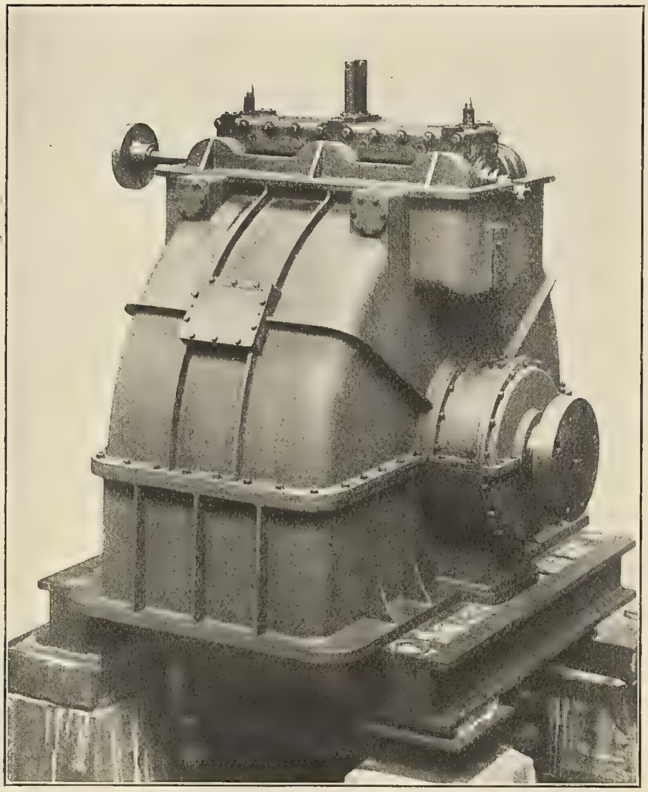


Fig. 1.—Reduction Gear Assembled

In order to avoid having the weight of the pinion and pinion frame coming on the teeth of the gear and pinion, the frame A is supported on struts BB held in adjustable sockets DD, which permit the vertical distance between the center of the pinion shaft and the gear shaft to be accurately adjusted, and to prevent the radial component of the pinion thrust lifting the frame from between its thrust abutments, a second set of adjustable struts CC and accompanying adjusting screws EE are provided, thus preventing the pinion shaft from moving away or approaching the gear shaft, but permitting motion in the horizontal plane. The struts and floating frame are shown in detail in Figs. 4 and 5. Oil for lubricating the pinion bearings and pinion gear is supplied through the opening H, which communicates through a sliding contact I, Fig. 4, which communicates with the port J extending the length of the pinion frame A, Fig. 4. A spray of oil floods the pinion through the ports KK and also supplies the bearings at the center line, or point of minimum pressure.

When a bearing rotates under load, unless metallic contact occurs, oil supplied at the point of minimum pressure of the bearing is carried around by the journal friction and the pressure of the oil film at the point where the load is carried must be sufficient so that the oil pressure times the bearing area is equal to the load on the bearing; otherwise the oil film would be destroyed and metallic contact would ensue as a result. By providing outlets at the point of maximum pressure, a bearing within the limits of its capacity may be employed as a pump, and this is what is done in the Westinghouse reduction gear, recesses being provided in the bearings at the point of maximum oil pressure in the bearings, which communicate with passages L, Fig. 5. A ball check valve M is provided in each passage L, through the bearings, and each of the passages L communicates through this check valve with a common space N, which is connected by passage O to the space behind the piston V. The total area of the pistons V is made approximately twice the projected area of the bearings, and hence an oil pressure of approximately one-half that of the oil firm in the bearings if exerted on the pistons V, is sufficient to balance the thrust of the pinion; thus as the pinion revolves under any given thrust, oil from the bearings at the pressure of the oil film in the bearings is pumped through the passages L to the space N, and through the holes

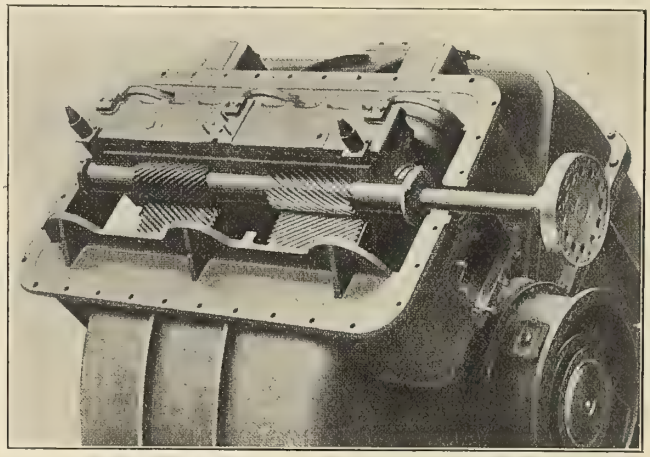


Fig. 2.—Pinion Frame Cover Removed

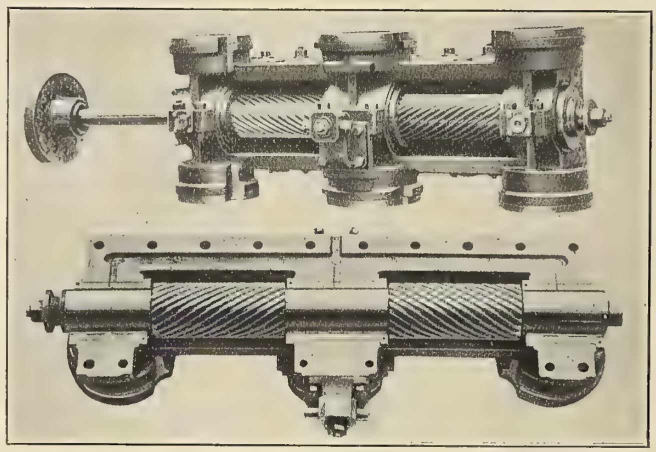


Fig. 3.—Pinion and Frame

O to the pistons V, balancing the movable or floating frame A, carrying the pinion in the direction of the arrow, or opposite to the direction of the pinion thrust, until the opening in the passage E, in the arm of the floating frame moves away from the movable seat Q sufficiently to permit the excess oil pumped by the bearings to escape and thus relieve the pressure behind the pistons V until the product of the area of the pistons into the oil pressure is just equal to the total thrust

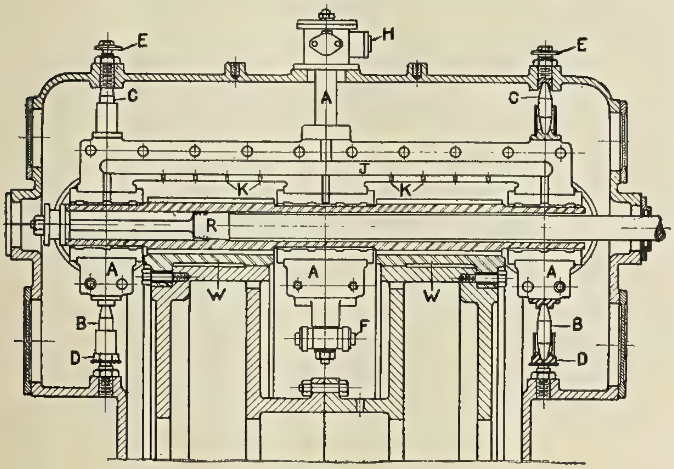


Fig. 4

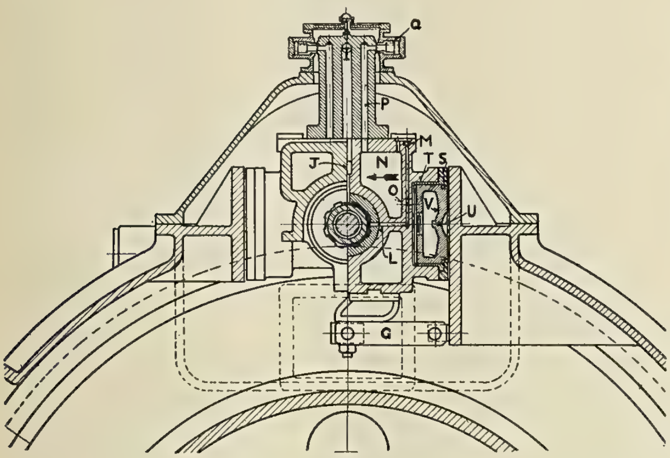


Fig. 5

on the pinion. Should the load increase, there is a tendency for the frame to be pushed over against the oil pressure behind the pistons V, and this brings the frame arm against the movable seat Q until the oil pressure behind the pistons again builds up sufficiently to balance the increased thrust; or if the thrust on the pinion decreases, the opposite action will take place. The seat Q is circular and has a shoulder which engages with the housing containing it, and it is held outward by a spring, thus forcing it in contact with the pinion frame arm until the frame takes the central position. This is made so that the frame normally when under no load can move back until the frame arm comes in contact with the gear housing. To prevent the pinion frame from tipping when the frame arm comes in contact with the housing, fulcrum F and fulcrum link G are provided which flexibly tie the floating or movable frame to the gear housing, as shown in Figs. 4 and 5.

Referring to Fig. 4, it will be noted that the pinion drive which passes through the hollow pinion is connected to it by a taper fit and circular keys at the point R in the middle of the after pinion. This reduces considerably the total torsional deflection of the pinion under load.

The gear wheels are made of cast iron with cast steel rims pressed on, as shown at WW, Fig 4. The steel castings from which the gear rims are made are cast two or three times the thickness of the finished rim and with a riser somewhat more than the width of the rim attached. The material used for the rims is mild steel, having an ultimate tensile strength of about 60,000 pounds, and an elastic limit of about 35,000 pounds.

Fig. 1 shows the gear and floating frame assembled complete ready for the pinion frame cover. The gages shown are for indicating the oil pressure behind the ahead and astern floating frame pistons respectively, and the pressure indicated on these gages multiplied by the area of the floating frame pistons in square inches gives the total effective thrust on the pinion, and this into the peripheral speed of the gear divided by 33,000 is the shaft horsepower transmitted. Experience has shown that the power transmitted is measurable, by this means with an error of less than one percent, so that the need of a torsion dynamometer on the propeller shaft is obviated. By connecting the oil pipes from the floating frame to recording gages and using recording tachometers, it is possible to keep a continuous record of the shaft horsepower developed. A special form of differential pressure gage may also be used which will record the horsepower direct.

The British Board of Trade Experimental Bulkhead Tank

Following the *Titanic* disaster, the British Board of Trade appointed a special departmental committee, with Sir Archibald Denny, Bart., as chairman, and Professor Welch, of the Armstrong College, Newcastle-upon-Tyne, as secretary, to inquire into the whole question of bulkhead construction.

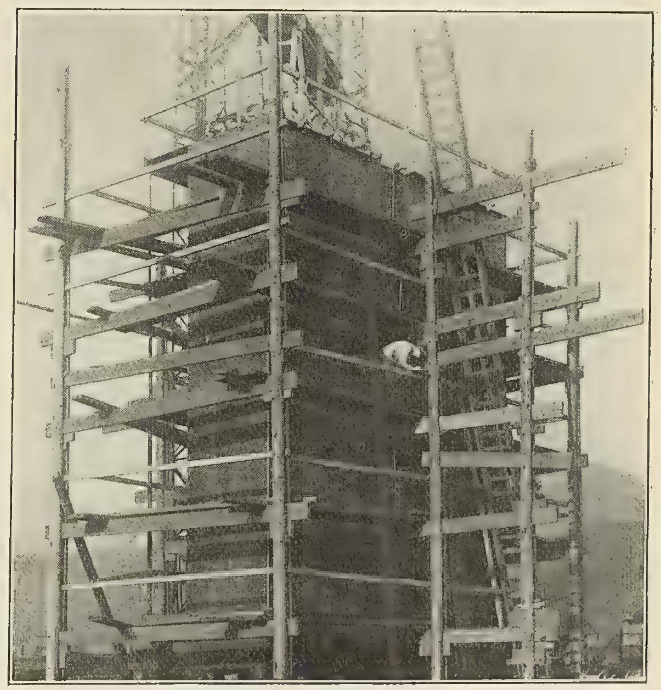


Fig. 1.—General View of Bulkhead Tank

This committee arranged for the building by Messrs. Swan, Hunter and Wigham Richardson, Limited, of Wallsend-upon-Tyne, of the experimental tank illustrated in Fig. 1. This structure is about 35 feet in height, 26 feet from side to side, and there is a distance of about 6 feet between the front and rear bulkheads. The bottom portion of the tank extends an additional 4 feet, so that the structure has a total width at the base of about 10 feet. On one side of the tank there

are three decks, 4 feet wide, thrown out and the spaces between them represent a ship's hold and two 'tween decks.

The plating of this tank was carried out partly in vertical strakes and partly in horizontal strakes. The stiffeners used both inside and outside the tank were of various sections, and in different places flanged plates, plain angles, bulb angles or channel bars were used. The design of the end attachments of the stiffeners also varied, for in some places angled lugs were used and in other places knees. Furthermore, these lugs and knees were of different sizes. In some cases no attachments were made at the ends of the stiffeners.

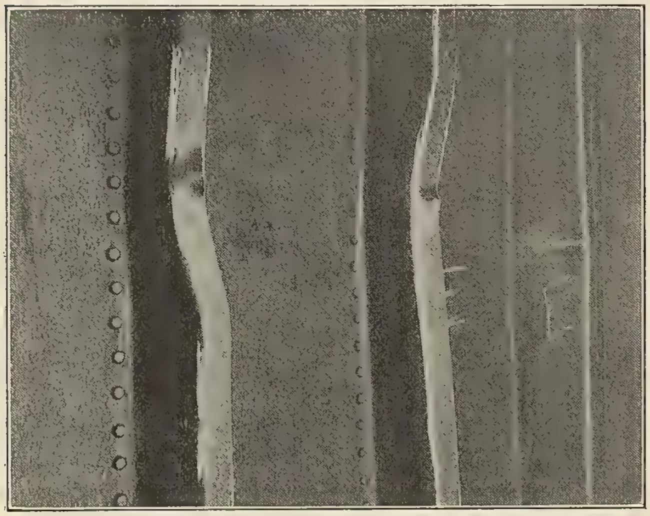


Fig. 2.—Effect of Water Pressure on Bottom of Tank

Fig. 3.—Vertical Stiffeners and Plating Bulged Outward by Water Pressure

The tank was equipped by Messrs. Swan, Hunter and Wigham Richardson, Limited, with water gages, and there is a service of pipes, so that the tank may be filled with water. During the experiments made by the bulkheads committee a much greater "head" or pressure of water was used than is ever likely to occur in an actual ship at sea, and in Figs. 2 and 3 are shown the vertical stiffeners and plating bulged outward by the pressure of water, and also the effect of the water pressure on the bottom of the tank, with the angle bar stiffeners bent and showing signs of fracture.

The bulkheads committee report to the Board of Trade will be published shortly, and meanwhile it is not desirable to publish further details or tables of the results arrived at during the recent series of exhaustive tests.

Motor-Driven Tank Vessel Avon

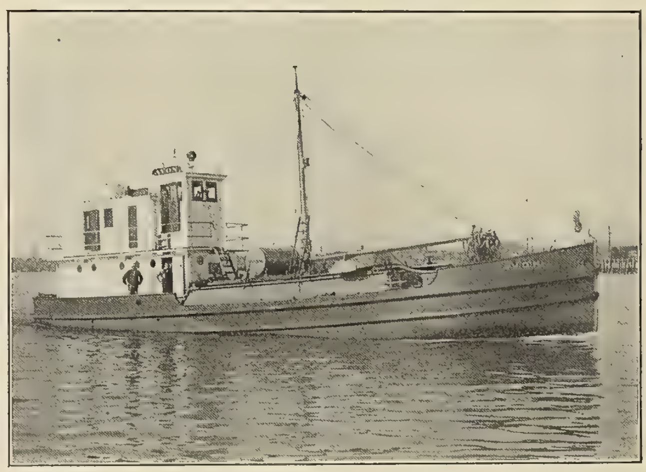
The most recent addition to the large oil-carrying fleet of the Associated Oil Company, of San Francisco, is the new steel tank vessel *Avon,* built to deliver refined oil from the refinery at Avon, California, to the different distributing stations about San Francisco Bay. The vessel is built of steel, and, on account of having to navigate shallow water, she has been built with a square knuckle at bilge. This formation has been carried around the stern, the propeller and shafting being supported by a skag.

The principal dimensions are as follows:

Length over all	81 feet 6 inches
Length between perpendiculars	74 " 6 "
Breadth, molded	16 " 0 "
Depth, molded	5 " 9 "
Mean draft with 20,000 gallons gasoline (petrol)	4 " 6 "

There are five athwartship bulkheads, and one longitudinal bulkhead at the center line of the ship, forming four cargo tanks. There is also a small hold forward for carrying drums and other miscellaneous cargo.

The engine room is aft, as are also the accommodations for the crew of five men. For a vessel of her size the machinery outfit is very complete. The engines were built and installed by the Union Gas Engine Company, of San Francisco. The main engine consists of an 80 horsepower three-cylinder Union engine of the open crosshead type, driving a four-bladed propeller. The engines used for pumping the cargo are two 12-horsepower double-cylinder Union engines driving rotary pumps by means of silent chain drives. One of these engines is also connected to a rotary pump for fire and bilge pump service. There is also a 6-horsepower Union hoist on this vessel, used for handling freight. The electric lighting system, including the ship's lights and a powerful searchlight, is supplied from a 4-horsepower Union single-cylinder electric lighting engine, direct-connected to a 2-kilowatt Westinghouse generator. With the heavy flywheels and flywheel governor on this outfit, an absolutely steady light is maintained without the use of storage batteries. The propelling engine is arranged to be controlled from the pilot house, in order that one man may handle the ship.



The *Avon*

On her trial trip a speed of eight miles per hour was attained.

How Marine Engineers Can Make Money—I

"Old Scotch," the Sage of the Engine Room, Shows How the Men Below the Gratings Can Add to Their Income

Brother marine engineers, anywhere and everywhere, how would you like to make an agreement with the owners of your ship so that beginning, say, on August 1 next, they would give you half the price of all the coal you saved for the next six months when compared to the amount you used during the preceding six months?

Say that you are on a ship making regular runs, using about five hundred tons a month, or three thousand tons for a period of six months, and by watching the corners carefully you cut down the fuel consumption only 10 percent, that would be a saving of six hundred tons. Half of this capitalized at $4 (16/8) per ton would mean a cash dividend to you amounting to $1,200 (£246) and the same amount to the owners. Not so bad to take, eh?

Of course, if you are the chief engineer you are not going to hog the whole amount. You will "divvy" it up judiciously with your assistants, your oilers, water tenders, firemen, and even the meek and lowly "snipes," so that every man jack of them would have an interest in the rake-off. If you didn't divvy it up let me say right here that you wouldn't make much of a record for economy during the next six months period.

Such a proposition as this saving-sharing may sound a little pipe-dreamish, but it has been done in lots of shore plants, and unless I miss my guess it won't be long before it is put in practice on board many steamships. It is a good thing for both of the interested parties, as they each profit by it. In these days of active competition and high prices the corners will have to be watched mighty carefully to break even on any kind of an investment. The cost of living still stays way up, wages are none too high now, so about the only thing left to economize on in steamship operating is the coal pile. Hence it is that all the inventors and engine designers are engaged in a mad race to get up the most economical method of propulsion, and we hear of internal combustion engines, electric drive, hydraulic transmission, turbines with and without reduction gears, combinations of reciprocating engines and turbines, and so on ad libitum. All have one object in view, and that is to reduce the fuel bills. Go to it, inventors and designers, and get up the most economical ship-driving apparatus you can. In the meantime those of us who have to drive the old-fashioned mills will have to do the best we can, and at that I believe there is lots of room for improvement and saving. We cannot very well alter the designs of the ships' machinery we are now running, but we can alter and improve our methods, which will perhaps save as much fuel as can be saved by improvement in designs.

But, you are saying, how are we going to save that 10 percent in the coal bills? All of us old-timers have, I am afraid, been lulled into the belief that the old three-cylinder triple we are running is just about the most economical machine that ever was. We get this belief quite naturally, as when we were youngsters and the first compounders were coming into use we thought they were the real things for coal saving. Along in the eighties the first triples appeared and then we were quite sure that we had arrived at the genuine all wool and a yard wide coal savers. Compared with the old single mills our daddies ran they are sure enough very economical pieces of mechanism. But as the old darky philosopher said, "The sun do move," and so does the world, but many of us have been standing still, so far as fuel-saving is concerned. What used to be a good record years ago would be looked upon as extravagant and wasteful nowadays, and to keep up with the times we have got to look into the new methods pretty carefully.

Do you know what "thermal efficiency" means? Well, I'll tell you, as I have just been put wise to that term myself. You can appraise coal nowadays just about the same as they appraise gold quartz. The only thing that interests a gold miner is how many dollars' worth of gold there are per ton of ore as taken out of the mine. With coal the question is how many British thermal units does it contain? Those are the things which make steam, and that's all we are interested in. Coal, such as we get on board our ships, contains all the way from 11,000 to 15,000 British thermal units per pound. A British thermal unit, you know, is equivalent to 778 foot-pounds of work, and if you want to take the trouble of figuring it out you will find that 1 horsepower is the equivalent of 2,545 British thermal units.

Old Scotch

With a good grade of coal, containing, say, 14,000 heat units per pound, you can see that if all of them were converted into horsepower at the engine our coal bills would be very small; but here's the rub, the great bulk of these heat units gets away from us without doing any useful work. This "thermal efficiency" means the proportion which the number of heat units turned into work at the engine bears to the total number of heat units in the coal shoveled into the furnaces. It may surprise you to know that about the most economical record ever made, using steam as a medium, has about a 19.4 percent thermal efficiency, and it is safe to say that the best record that the triples you and I are jockeying every day have a thermal efficiency of not more than 12½ percent at the very best. In other words, for every eight shovelsful of coal we are putting into the furnaces, seven of them might as well be thrown overboard, so far as this "thermal efficiency" stunt is concerned. The problem before us is, therefore, to corral some of these wandering thermal units and put them to work in order to make that 10 percent saving in the coal we are now using. If the editor will allow me, I'll try to show in the next issue where some of them at least can be saved from wandering.

Yours for economy,

The Rational Non-Diesel Marine Oil Engine

BY ALBERT H. ZIEGLER

The requirements for the design and construction of such an engine as was outlined in the last instalment of this article would be as follows: All portions of the interior of the combustion chamber should be water-jacketed. No hot bulbs, tubes or plates should be used. In large units, for deep sea, heavy-duty work, the engine should be directly reversible and equipped for starting on compressed air at pressures not over 50 pounds per square inch. As at least a warm combustion chamber is necessary for preventing the condensation of an atomized fuel charge, provision should be made for starting the engine without resorting to gasoline (petrol). This can be accomplished by previously heating the jacket water in a small, simplified, blow-torch heated boiler in thermo-syphon communication with the jackets of the cylinders and cylinder heads. In addition, the initial air charges upon starting the engine can be drawn hot from the same heater or boiler. Once having started, however, all succeeding air charges to the cylinder should be of the same temperature as the outside air. No heat should be imparted to the subsequent charges until they are inside the engine cylinders, thus insuring a maximum volume of charge and a high mean effective pressure.

The vacuum in the inlet pipe up to the inlet valve seat should be as low as large pipe sizes will allow, being not over ½ pound gage corresponding with a velocity of about 70 feet per second. The oil fuel should be atomized directly at the inlet valve seat. No compressed air should be applied for atomizing, as compressed air in expanding would produce a refrigerating effect, increasing the viscosity and vapor tension of the oil fuel, and making its complete atomization more difficult. Before being atomized the fuel oil should be heated almost to its "cracking" point to decrease its viscosity and vapor tension, and therefore aid complete combustion by being passed through hot portions of the cylinder head. In order to completely atomize oil fuels at the lip of the inlet valve by means of the air velocity, a comparatively high velocity is required varying according to the density and viscosity of the fuel used. With solar oil preheated as prescribed, a velocity of about 170 feet per second is required past the oil spray holes or tubes. Coal oil would require a velocity of from 190 to 200 feet per second, as would heated oils of heavier weight.

Means must be provided for controlling the quantity of fuel supplied in proper proportions for all loads and speeds, and also for assuring a constant velocity past atomizing tubes at all engine speeds. A constant richness of the fuel charge is not suitable for varying rates, as the charge should be slightly richer at light loads than at heavy loads on account of the higher compressions attained at heavy loads. A mechanically operated inlet valve having a uniform lift at all loads and speeds would not produce a uniform velocity past the valve seat for oil atomizing. The velocity would vary in direct proportion to the engine speed. If the atomizing velocity were correct for high speed the fuel would not be properly atomized at low speed, and the engine would not be flexible. A mechanically operated inlet valve with a variable lift, acting as a throttle, would reverse the range of velocities, giving a much higher velocity at low engine speed than at high speeds. A separate throttle in the inlet pipe, acting in conjunction with the variable lift inlet cams of link motions, might be so adjusted as to produce a practically uniform velocity past the valve seat, but the resulting complication of the variable valve lift and throttle mechanism would hardly prove justifiable. A throttle in the inlet pipe, acting entirely independently of properly-designed light, automatic inlet valves, equipped with dash-pots at the end of their stems, would undoubtedly prove the simplest means for insuring an entirely uniform velocity for oil atomization at all loads and engine speeds.

If the engine were running at full load, and at high speed, with the throttle wide open and the inlet valve spring tension adjusted so as to produce the proper atomizing velocity past the valve seat, that velocity will remain constant at all the other speeds, however much the vacuum between the throttle and the inlet pipe may be increased, due to throttling of the engine. This is true because the velocity of a gas through an aperture is dependent upon the ratio of the pressures on both sides of that aperture, whether the pressures involved be high or low. In other words, the velocity would be as high through any aperture with a pressure of 2 pounds absolute on one side and a pressure of 1 pound absolute on the other side as the velocity caused with a pressure of 1,000 pounds absolute on one side and of 500 pounds absolute on the other side. The ratio of the pressures is the same in each case; that is, 2 to 1. In the case of the automatic inlet valve, set to require a definite ratio of absolute pressures above and below it to lift the valve off its seat, reducing the pressure above the valve by throttling, requires a reduction of the pressure below by the action of the engine piston, the valve not opening until the proper ratio between the pressures is established and flow velocity will be the same as when no throttling existed.

Though the velocity of flow remains constant, the volume of flow is less when throttled as the density of the charge is reduced by rarefication. For a different richness of the explosive charge the amount of fuel atomized into such a rarefied air charge should be proportionately reduced. The atomizing nozzle should be so designed as to pass the air at its highest velocity squarely across the nozzle. The lip of the nozzle should be gradually expanded in a conical or other shape, such as will spread the fuel out in a very thin film before subjecting it to the atomizing process on the edge of the nozzle. By means of inclined vanes or fins in the throat of the inlet valve, the incoming air charges may be given a radial motion which continues for an appreciable time after the charge has entered the cylinder, tending to mix the air and atomize the fuel more intimately and preventing stratification.

If the engine is started up under heavy load, no water need be used in the cylinder until the engine has become heated up appreciably. Under less than about 40 percent load it is seldom that any water need be used with most oil fuels. When the load exceeds 40 percent of the rated output, however, the need for more or less water in the cylinder becomes apparent. This water supply, as well as the fuel supply, should be accurately proportioned, according to the change of load on the engine, and should be as finely atomized or subdivided into the charge as is the fuel. As nearly all water contains various quantities of mineral matter, either in solution or in suspension, it is advisable, in order to prevent the accumulation of such matter in the engine cylinder, to arrange for distilling the water required.

There have been instances where the exhaust heat of an engine was used in a very simple form of evaporator, and about 1½ pounds of water per horsepower-hour were thus evaporated. As oil engines require about as much water in the charge as the fuel consumed, the exhaust heat is, therefore, abundantly able to evaporate much more than would be required. By depending upon the distillation process for this water, it would be unnecessary to provide tank capacity for carrying the water on board ship, which would be a considerable saving of space. Such water could also be distilled from the salt water in the cylinder jackets, which is heated to about 160 degrees F.

If it is attempted to pass the steam from the evaporator directly into the cylinder, care should be taken that such steam is cooled to the saturation point; that is, until it is just ready

* Concluded from the June number.

to re-condense; for steam is really a very dense fluid matter and takes up a good deal of space. Unless cooled to a state practically bearing on nearly atomized water, the quantity required in the cylinder at each charge will crowd out just so much explosive mixture as is represented by the difference between its volume in the shape of steam and its volume in the shape of water. For reliability of operation it would probably be better to entirely condense the steam; pass it to atomizing nozzles at the seat of the engine inlet valve at a temperature of about 200 degrees F., when its vapor tension is very low, assuring ease in atomizing.

The compression pressures carried in such engines depend upon the chemical composition of the fuel used and upon the amount of atomized water used in the charge, but past experiments along this line have given abundant evidence that compressions of 250 pounds and upwards may be easily and reliably attained in such non-Diesel engines. The consumption of fuel per brake horsepower-hour will, of course, be greatly affected by the degree of compression carried, a low compression resulting in a higher fuel consumption than very high compression. It is due to the very high compressions carried in the Diesel engine, which are so necessary for their correct operation and for self-ignition, that the fuel consumption of such engines is so remarkably low, although it might be reasonably suspected that if Diesel engines could be operated under lower compressions than 450 to 500 pounds the resulting ease and cheapening of manufacture and of upkeep gained might be more of an inducement to manufacturers and purchasers than the slight difference in fuel consumption involved.

It would perhaps be demonstrated after trial and experiment that the compression pressures advisable in the type of non-Diesel engine above described would vary according to the density and composition of the oil fuel in each case, just as compressions advisable are found to vary in engines burning gasoline (petrol), city gas, natural gas, blast furnace gas and alcohol, though with the different grades of oil fuels it is very probable that the range of compressions would not vary to such high limits.

Care of the Electric Plant on Board Ship

Care of Switches, Plugs and Fuses—Troubles to Look for and How to Remedy Them

BY SIDNEY F. WALKER

One rule may be given in connection with switches that are used on board ship; always have them as large as possible. No rule can be given as to the extent of switch surface per hundred amperes of current, as is usually given. Ship work is quite different from any other; and even on shore, the switches are very often too small. The only rule that is at all applicable is: have the switches, the circuit breakers, the wall plugs, everything except fuses, as large as space and funds will allow.

Switches

The writer had a very interesting experience a good many years ago, in connection with colliery work. He has a large experience with colliery work, and with ship work; and he has found that the conditions applicable to the two are to a large extent similar. In the early days of electric light and power work in collieries, the switch problem was a very troublesome one. Mine owners would not pay for substantial switches; but in many cases the colliery mechanics made switches themselves; and when they did, they made them in colliery fashion; very rough, but with plenty of material; and they stood better, far better than any of the switches made by the best firms in the trade at that time.

The great point to bear in mind about switches is: that as large surfaces as possible should bear against each other at the actual switch contacts. Modern switches are turned out very much better; the machinery is far superior to that of twenty years ago; and the bearing of the two sets of contact surfaces upon each other, when the switch leaves the factory, are far better than they were in those days. But immediately a switch is taken into service all sorts of things come against it. There is the wear of the two surfaces, as the switch is thrown in and out, and, what is of far more importance, there is the spark which passes between the contacts whenever the switch is opened. This spark carries a small quantity of the material of which the switch is made, usually brass, from the positive side to the negative, and sometimes to the contact bar. The modern switch is made to break very quickly, so that the spark is the smallest possible; but it sometimes happens that the spring of the switch becomes weak; it may be exposed to heat, especially in some places where it has to work on board ship; and then the contact bar will not leave as quickly as it should do, and the spark may be followed by an arc.

Every switch on board the ship should be carefully examined as often as possible; and the larger the current controlled by the switch, the more frequent should be the examination. Every sign of wear should be promptly removed, and the surfaces made good. Every sign of a weakening spring should be promptly made good. It is not difficult for marine engineers to replace the springs that are used to bring the contact bar away from the contacts, and it is not difficult to carry spare switches. The slightest sign of wear or of fusing at any one of the switch contacts should be immediately attended to. It will be wisest to replace the switch by a spare one, and carefully overhaul the damaged one at leisure. The small switches that are employed to control single lamps usually stand very well, but there is always the danger on board ship of salt having deposited upon some of the contacts or upon the terminal screws, or upon the wires connecting them, and it will therefore be wise to examine these periodically, and to clean off any green deposit that is formed.

Plugs

Where wall plugs are employed for portable lamps they should receive the greatest care, and should be overhauled very frequently indeed. It will very often be found that the female portion of the plug, whether it is a two pin or a single pin plug, is dirty. Grease and other dirt may get in while the plug is not in use, and the sparking referred to above will also tend to build up a dirty surface. The female portions, which usually consist of tubes, can be cleaned by means of a piece of emery wrapped round a stick cut exactly to the size.

Flexible cords should also be very frequently examined, and should be tested with the insulation testing apparatus if there is one. Any sign of wearing on the outside of the cord should be promptly suspected, a more careful examination made there, and unless it is very clearly seen that no damage has been done, that piece of cord should be cut out. The cost of a piece of cord is practically nothing compared to the cost of a fire, and a fire may very easily occur if the two flexible conductors in a flexible cord come into contact, making a short circuit. The cord itself is wrapped with

usually fairly inflammable material, and the heat developed by a short circuit in the cord, under the conditions ruling on board ship, would cause a fire in a very short time.

Circuit breakers, where they are employed, should be carefully examined periodically. They are usually provided with carbon breaks, the spark or arc which passes when the breaker opens being set up between the two carbon surfaces. Naturally the more frequently the breaker is opened the more the carbon is worn, and the carbon contacts should not be allowed to wear very much before they are replaced. It should be understood that in all these matters it is the old tale of the stitch in time. The earlier a trouble of this kind is located, the more easily it is prevented. A little wear is easily provided against, but if it is allowed to go on, the fact of the existence of the wear will lead to greater sparking, greater arcing, and a rapid increase of the wear and of the arcing.

Starting Resistances

Starting switches and resistances of motors require perhaps greater care and looking after than almost any other switches about the ship. Again, the rule mentioned at the commencement of the article, to have the apparatus as large as possible, is of special importance here. It may and does often happen on board ship that space forbids the use of a large apparatus; in that case, use one as large as can be got in, but so that it can be got at for repairs. See that the contact pieces are large; that there is a large extent of surface of the contact bar bearing upon each contact piece; see that the contact bar bears equally upon each contact piece; and examine the whole of the contact pieces frequently for signs of wear or sparking. Signs of wear or sparking should be immediately made good. The contact pieces should be sufficiently far apart to prevent arcing between two adjacent ones; but not too far apart, or the distance itself may lead to arcing. Modern starting switches are very carefully made, and may be trusted to be all right in that respect when they are sent out; but, as remarked above, from the moment they are put into service, everything tends to put this nice state of things out.

The starting resistance should also be examined at fairly frequent intervals. There is a tendency for the resistance to be too small, and when that is so, or if it is left in connection for too long a time, the connections between the contact blocks and the different sections of the resistance may be broken. Periodical examination will prevent any tendency towards this. On board ship there is also the tendency for a deposit of the salts from the ocean, which, assisted by the current which is passing, will tend to break the connections. Any trouble of this kind may nearly always be seen, long before it does any harm, by the presence of that green powder known in domestic life as verdigris; or in scientific language, one of the salts of copper, either the sulphate or the chloride.

An important caution should be given here; starting switches and resistances should never be employed for regulating the speed of motors. Starting switches and resistances are designed on the understanding that they are only in use, and consequently the current is only passing through them, and particularly through the resistances, for the very short period during which the motor is being started up, a few minutes at the outside. If the resistance is left in circuit, and if the starting switch is left with its contact bar on one of the contact blocks, as it would be if used to regulate the speed of the motor, by varying the resistance of some part of the machine; the resistance, and usually the contact block and contact bar, will heat up. Heat, when developed at any part of the apparatus, except in the lamps, and in the armature of the generator or motor, should be looked upon with suspicion. A hot switch, a hot lamp holder, a hot fuse, should be looked upon with suspicion and promptly overhauled.

Fuses

Fuses stand in quite a different position to switches. The terminal blocks of a fuse must be sufficiently substantial to stand the vibration of the ship, and all that comes against electrical apparatus on board ship, but it is necessary that they should not be too substantial; they should not be too large; because they will carry off a considerable portion of the heat that is developed in the fuse when a short circuit occurs. Under the very best conditions, and with the greatest care, they will carry off a certain portion of the heat; always less in a fairly hot engine room than in some drafty alleyway; but the smaller the amount they can be allowed to carry off, that is to say, the smaller their size, consistent with mechanical strength, the better.

Fuses themselves require careful attention, and very frequent examination. No matter what the metal may be of which the fuse is composed, from the moment it is put into service, oxidation takes place, to a greater or less extent; and the fuse is liable to "blow" with a smaller and smaller current. The enclosed fuses which are now so common are protected to a considerable extent from oxidation; but even with them there is a tendency for the fuse to "blow" with a smaller and smaller current; and they should therefore be examined and changed periodically. With enclosed fuses, and in fact with all kinds of fuses, care should be taken to see that the fuse itself is not broken. The enclosed fuses usually have some indicator to denote when the fuse has "blown"; but all of them do not show when the fuse is broken. Of course, if a fuse is broken, the circuit controlled by that fuse is open. The trouble is that a fuse may go; it may "blow," or it may simply open the circuit without actually blowing; this is possible, owing to the weakening effect that is mentioned above.

The Watertight Subdivision of Ships and the Effect of Bilging—III

BY A. L. AYRE

Fig. 8 represents a vessel damaged at the bows to such an extent as to cause the flooding of No. 1 hold as well as the forepeak. In Fig. 9 the curves of weight and buoyancy for the normal condition are shown by the full lines W and B, respectively, while the dotted curve B_1 shows the amended curve of buoyancy owing to the bilging of the fore end. It is obvious, of course, that the weight curve is the same for both conditions, and we may therefore restrict our attention to the resultant effect of the new form taken by the curve of buoyancy in the damaged condition.

The great change takes place at the fore end, where the bilged compartments are situated, and the only buoyancy remaining is that contained in the cargo and shelter 'tween decks, as shown by the dotted curve. Immediately abaft the bulkhead which bounds the after end of the flooded space, the buoyancy is intact, and at this point, M, owing to the large amount of change in the trim, a huge increase in buoyancy is seen as compared with the original condition. On reference to Fig. 8, where the relative positions of the waterlines are shown, the reason of this great increase is also seen. The difference in buoyancy for the two conditions is now seen to becomes less and less until the point F is reached, where, as seen in Fig. 8, the old and new waterlines intersect each other, and, of course, the amounts of buoyancy at this point are equal. From this point towards the after end of the vessel, owing to the change of trim, the new amount of buoyancy is less than previously existing, as the after end of the vessel has been lifted out of the water.

Fig. 10 shows the curves of *loads* for the original and dam-

aged condition by the full and dotted lines L and L_1, respectively. The curves of loads which show the variation of positive and negative loading throughout the vessel's length, or the net difference of weight and buoyancy for both conditions, are drawn to show excesses of weight below the base line and excesses of buoyancy above the base line. In this diagram the new relation of weight and buoyancy is more easily seen, and compared with that previously existing, the new excess of weight, shown below the line, being nearly double that of the old amount, while a proportionate increase is also noticed in the case of the excess buoyancy shown above the line.

The further effect is shown in Fig. 11, where the full and dotted lines $S\ F$ and $S_1\ F_1$ represent, respectively, the original and the new curves of shearing forces, each of which are the integral of the respective curve of loads. A huge increase in shearing force occurs at the after end of the damaged compartments, where the great change in amount of weight and buoyancy takes place (see curve of loads), the new shearing force being more than double that experienced when the vessel was floating in her normal condition, and in some cases such an increase would no doubt have a serious effect on the vessel's structure.

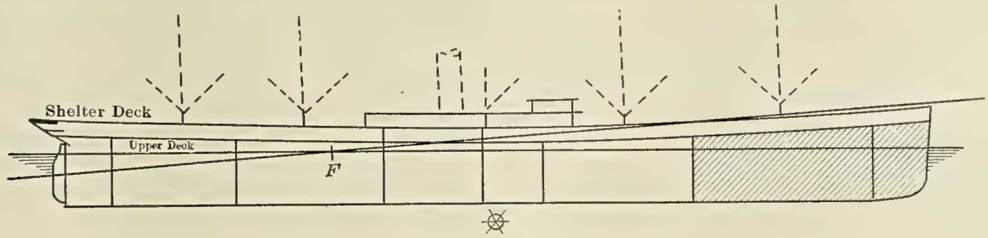


Fig. 8

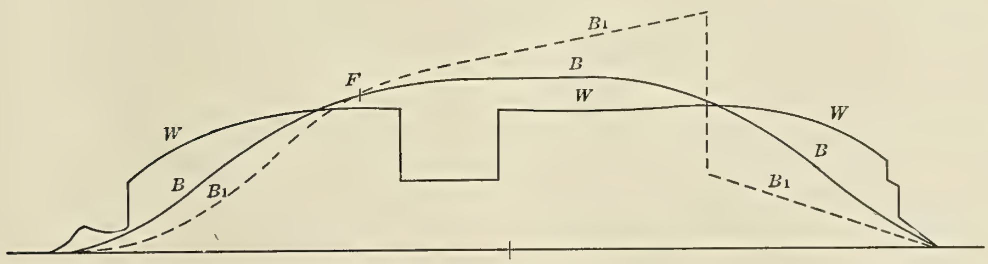


Fig. 9

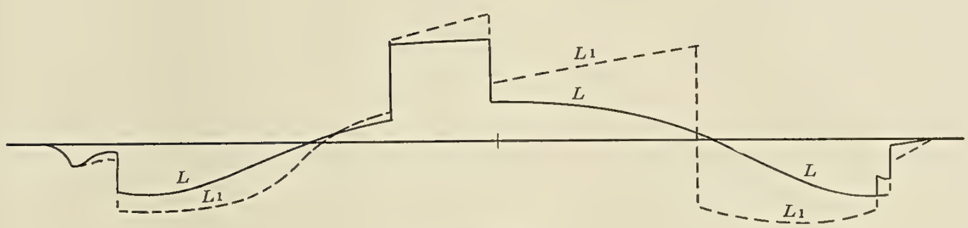


Fig 10

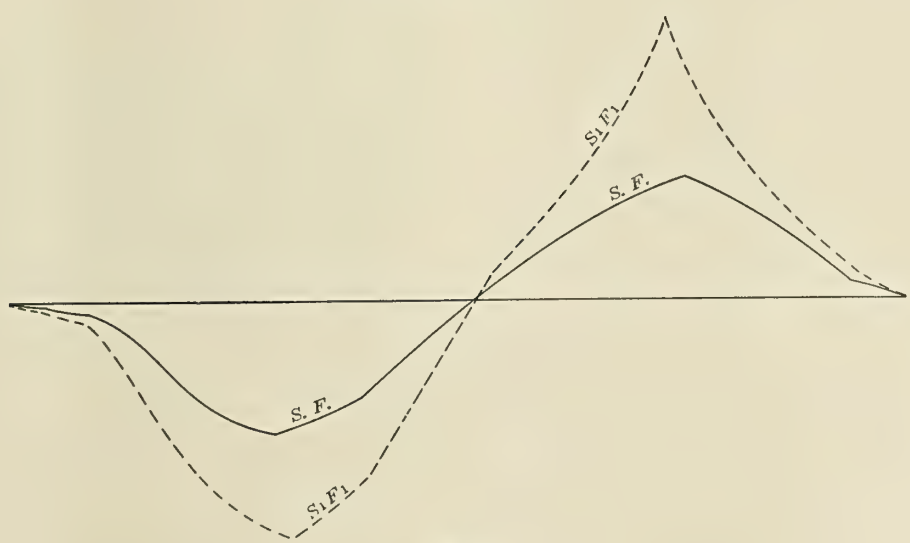


Fig. 11

The effect on the longitudinal bending moment is shown by Fig. 12. The curve of bending moments is the integral of the curve of shearing forces, and owing to the large increase in area in the latter curve for the damaged condition a cor-

responding increase of bending moment is found. In Fig. 12 the curve for the damaged condition is again represented by the dotted line, and the maximum ordinate is seen to be greatly in excess of that for the normal condition.

It is therefore seen that the resultant effect of bilging on the vessel's strength may be a matter of most serious importance in regard to both the shearing force and the bending moment, and it is quite easily understood why some vessels, as a result of bilging, have broken into two parts before sinking.

(*To be continued.*)

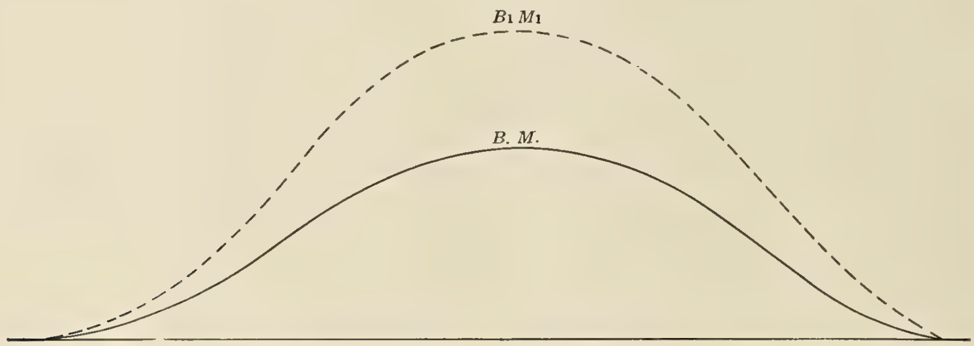


Fig. 12

Gatun Hydroelectric Development for the Panama Canal

The permanent supply of electric energy for the Panama Canal is generated in the Gatun hydroelectric station, which is located at the Gatun spillway dam. The tremendous water storage in the artificial Gatun Lake, fed by the Chagres River, not only carries vessels the greater part of the way across the Isthmus on a level about 85 feet above the oceans, and provides water for raising and lowering them gently through the Gatun, Pedro Miguel and Miraflores locks, but it also has afforded an excellent opportunity to generate electric curent for lighting the canal, for operating the gigantic gates and other locking machinery, and for the locomotives towing ships through the locks. Electric current will likewise be used for coal handling plants at both ends of the canal, for machine shops, waterworks, drydocks, and possibly in the future for hauling trains on the Panama railroad. To insure continuity of service in case of accident, a steam-electric station at Miraflores, erected a few years ago to supply power for construction work, will be ready to pick up the load when necessary.

The extreme length of the canal is about 50 miles, it has a minimum depth of 41 feet and the channel varies from 300 to 1,000 feet wide. The famous Culebra Cut has a length of about 9 miles. The crest of Gatun Dam has a length of 8,000 feet and an extreme width of 2,100 feet, the height above the normal lake level being 30 feet. There are three double sets of locks at Gatun, one double set at Pedro Miguel and two double sets at Miraflores. The average lift of each set is 28½ feet, the length of each chamber being 1,000 feet, and the width 110 feet. The time required for the passage of vessels through the locks is about three hours, and through the canal from ocean to ocean eight to ten hours.

The complete equipment for the power and distribution system on the canal comprises a 7,500 kv-a., 2,200 volt hydroelectric power plant at Gatun; a 4,500 kv-a., 2,200 volt Curtis turbo-generator electric power plant at Miraflores for emergency; a double 44,000 volt transmission line across the Isthmus, connecting Cristobal and Balboa with the two power plants; four 44,000-2,200-volt substations, stepping down at Cristobal and Balboa, and up or down at Gatun and Miraflores, depending on which of the two plants is supplying power; thirty-six 2200-240 volt transmission stations for power, traction and light at Gatun, Pedro Miguel and Miraflores locks; three 2200-220-110 volt transformer stations for the control boards at the locks; and stations at Cristobal and Balboa for the coal handling plants, machine shops and drydocks.

The Gatun Hydroelectric Station has a capacity of 6,000 kilowatts; and provision has been made to increase this to an ultimate capacity of 12,000 kilowatts, should this amount of power be required later for the operation of the Panama Railroad. The gross head available from Lake Gatun to mean tide level of the Pacific Ocean varies from a maximum of 91 feet in the extreme flood times to a minimum of 79 feet, to which level the lake may possibly drop toward the close of the dry season. The plant is designed consequently to develop the full water output when operating under an effective head of 75 feet.

The three 2,000 kilowatt main generating units in the Gatun hydroelectric station are each driven by a special 50-inch, vertical, single runner, Francis turbine manufactured by The Pelton Water Wheel Company. Each turbine has a maximum capacity of 3,600 horsepower when operating under an effective head of 75 feet and at a normal turning speed of 250 revolutions per minute. The turbines are located at such a height that the center of the runners is 20 feet above the tail water level. The turbines are of the spiral case type and are fitted with heavy cast iron distance rings which carry the generators.

The generators, under official tests, showed an efficiency of 95.1 percent at 2,000 kilowatt, 0.8 power factor.

The complete hydraulic equipment for this installation was designed and built by The Pelton Water Wheel Company; and all the electrical apparatus was designed and built by the General Electric Company, Schenectady, N. Y. The shipping weight of the material furnished by The Pelton Water Wheel Company, including the auxiliary electrical apparatus purchased by them from the General Electric Company, was approximately one thousand tons.

Busch-Sulzer Diesel Engines for United States Submarines.—The Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo., recently closed a contract with the Lake Torpedo Boat Company for six 600 brake horsepower reversible two-cycle marine Diesel engines for installation on three twin-screw submarine torpedo boats now building for the United States navy. Each engine will be provided with two separate scavenging pumps, arranged in line with the working cylinders, and also with two three-stage injection air pumps, all operated from the crankshaft.

The Passing of the Clipper Stem

BY DAVID A. WASSON

A short time ago the American steamer *Jacob Luckenbach,* on her way down Chesapeake Bay, ran into the German steamer *Sigmaringen,* up-bound. It was a crash such as has sent many staunch ships to the bottom, yet it only slashed a hole in the German's side five frames wide, and left the *Luckenbach's* bowsprit and part of her stem in the foreigner's vitals. The *Luckenbach* has a clipper stem; and this feature, it is believed, saved the *Sigmaringen* from becoming a sunken hulk at the bottom of the bay.

Incidentally this unique Yankee tramp is a cosmopolite of the deepest dye. She was built at Sunderland, in 1881, was originally named *Hermann* and flew the Belgian flag. Next she went into Norwegian ownership and was renamed the *Hero.* Wrecked on the Atlantic coast a dozen years ago she was salved, placed under the American flag and christened *Success,* only to change owners and her name again a few years later.

To-day steamers with long, gracefully projecting prows like the *Luckenbach's* are rare sights afloat in any sea. All the modern liners have severely plain perpendicular stems. The newest of steam or gas-propelled pleasure craft follow suit. Even sailing yachts are nearly all designed nowadays with the so-called "spoon bow," the reverse of the clipper stem in profile. The picturesque old overhanging bow, with its ornate figurehead, seldom is seen but on dwindling windjammers of the old school and superannuated yachts.

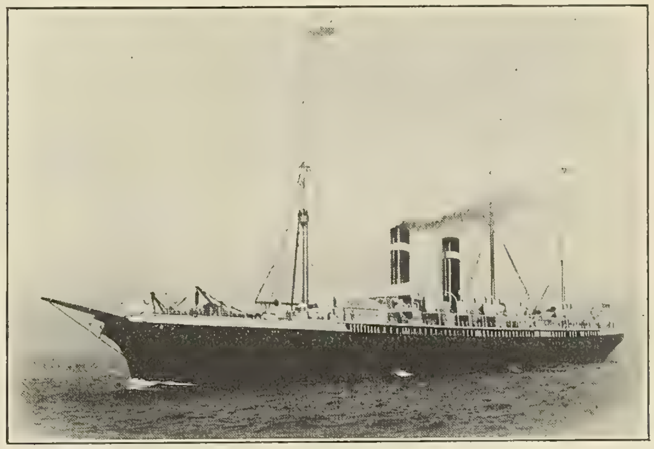
Nevertheless the clipper stem had distinct advantages. Various authorities have recently expressed surprise at its discard by naval designers. In the press a prominent English architect not long ago deplored its passing. He declared that

Canadian Pacific Steamship *Empress of Japan*

the steamship interests which are trying hard just now to meet the popular clamor for greater safety at sea might easily take a long step in the right direction by the simple restoration of the old-time clipper stem. To the argument that future oversea travel will know no collisions nor encounters with deadly icebergs is made the indisputable rejoinder that we live in the present. Yet in the world-wide agitation for the unsinkable ship the merits of the clipper stem seem to have been generally overlooked.

As proved by the *Luckenbach* collision just mentioned, the forward overhang of the clipper stem acts as a shock-absorber; inflicts its heaviest damage far above the waterline, and so lessens the risk of colliding steamers damaging each other fatally. Moreover, the topsides of clipper stem steamers flare or expand laterally forward, obviously giving added buoyancy. And certainly, if beauty ever again becomes a consideration in the construction of ocean greyhounds, all will wear the long, sweeping bow and dazzling figurehead now so nearly unknown.

Not a few ships besides the *Luckenbach* and *Sigmaringen* have owed their existence to clipper stems. The steamship *Pereire,* of the French line, bound from Havre to New York with several hundred passengers aboard away back in 1879, rammed an iceberg off the Grand Banks, not far from where the *Titanic* sank. The impact crumpled her bowsprit, figure-



American Line Steamship *New York*

head and clipper stem into a twisted mass of scrap iron, but they took the brunt of the blow. She reached port in a desperately crippled condition, but thankful to be there at all.

The *Pereire* is still afloat and active, and one of the oldest iron craft in commission, having been built at Glasgow in 1864. She is now a full-rigged four-masted ship, the *Lancing,* hailing from Christiania, Norway.

The four-mast, three-funneled British steamship *City of Rome,* the fastest, largest and most beautiful liner of her day, also ran into an iceberg off Newfoundland on one of her early passages, and there is none to say that her overhanging bow did not save her.

Unfortunately the *City of Rome* is no more, for some ten years ago she was broken up for junk. Built in 1881 for the crack Inman Line, this splendid ship repeatedly broke speed records in her palmy days. Eclipsed by newer and larger ships, she was sold to the more leisurely Anchor Line. While under this ownership she was requisitioned as a transport to carry home in September, 1898, the Spanish prisoners of war from their detention camp at Portsmouth, N. H. In 1901 she took another step downward in the nautical social scale when she was sold to Italian account. Shortly thereafter the shipbreakers got her.

On the Pacific the Canadian Pacific Railway's white-painted beauties, *Empress of Japan* and *Empress of India,* plying between Vancouver and the Orient, and a few old foreign-built United States army transports acquired during the Spanish war, keep the clipper stem from extinction among steamers. The *Empress of China,* a duplicate of the other sovereigns, was wrecked two years since.

At the present time just three transatlantic steamships with clipper stems are known to the port of New York. All are foreign-built and, as ships go, are well along in years. The *New York* and *Philadelphia,* of the American Line, run steadily and without mishap between England and the metropolis. The British steamer *Oceana* has been out of commission for some time at New York. She was lately sold by the defunct Bermuda-Atlantic Line to the Morse Dry Dock Company of that city. So far as known, not an ocean-going

merchant steamer with a clipper stem has been built since she was launched at Dumbarton, Scotland, in 1891.

Some years since, when the *Oceana* was owned by the Hamburg-American Line and flying German colors, the writer was aboard her in a winter southwesterly gale in the North Atlantic. One of her officers remarked that the 9,145-ton *Lusitania* couldn't have gone through it without shipping more water than was scooped aboard by the *Oceana*, 4,278 tons. Which alone many travelers will consider sufficient proof of the need for more clipper stems.

Side=Wheel Steamer Hanover

The Harlan & Hollingsworth Corporation, of Wilmington, Delaware, have just completed the light draft side-wheel steamer *Hanover*, for the Louisiana Steamboat & Ferry Company, New Orleans, Louisiana. This vessel is intended for service on Lake Pontchartrain, running between Milneberg and Mandeville, which are situated on opposite sides of the lake. For eight months in the year the vessel will be used for commutation service in connection with the railways, and during the winter season it will be used along the Mississippi River for afternoon and evening excursions.

The principal dimensions are as follows:

Length over all	188 feet
Length beteen perpendiculars	180 feet
Beam, molded	32 feet
Beam, over guards	54 feet
Depth, molded	8 feet 6 inches
Depth at lowest point of sheer	8 feet 6 inches
Depth at center	9 feet
Load draft	5 feet
Load displacement	480 tons
Speed	designed 14 miles per hour

Paddle Wheels

Type	Feathering
Number of buckets	9
Diameter over buckets	18 feet 5 inches
Length of buckets	7 feet 6 inches
Width of buckets	3 feet

Engines

Number	2
Type	Single-cylinder inclined
Cylinder diameter	25 inches
Stroke	7 feet
Indicated horsepower	designed—about 600
Valves	Corliss type
Condenser	Surface type
Cooling surface	About 1,380 square feet

Boilers

Number	2
Type	Cylindrical return fire tube
Pressure	90 pounds per square inch
Length	10 feet 9 inches
Diameter	10 feet 3 inches
Furnaces	
Number	2
Diameter	4 feet 2 inches
Grate area	85.2 square feet
Heating surface	2,592 square feet
Draft	Natural

Due to the limited depth of water in the lake, the vessel has been designed to carry 1,000 passengers, fuel, and stores on a 5-foot draft.

Hull Construction

The hull is of steel to the main deck, with the usual wood superstructure above. The keel is 18 pounds amidships, reduced to 15 pounds at ends, the bottom, bilge, and side plating is 11 pounds to 9 pounds at the ends, the shear strake is 15 pounds, reduced to 13 pounds at the ends. The frames are 5 inches by 3 inches by 8.2 pounds, angles with channel floors spaced 24 inches in the machinery space; forward and aft of the machinery space the frames are 4-inch by 3-inch angles, with 10-pound floors flanged on top to form reverse bars. The deck beams are 5 inches by 7 pounds structural channels on every frame with 10-pound knee brackets. The web frames, of which there are seven, are 10-inch channels extending from keel to deck with larged flanged brackets connecting them to the beams. There are two webs in the forward hold, one in the boiler space, three in way of the shaft, one in the engine space, and one in the after hold. There are three lines of keelsons in the hold on each side of the center, composed of 10-inch channels notched out to fit over the frames, and having 2½-inch by 2½-inch backing bars connected to the standing flange of the frame and the keelson. These keelsons are run from the stem to the stern, and are fitted intercostally between the bulkheads and webs.

There are five watertight bulkheads of 8-pound plate, with single 3-inch by 3-inch bounding bars stiffened by 4-inch by 6¼-pound channels spaced 30 inches vertically and 4 feet horizontally. The deck is fitted with tie-plates 12 inches wide by 10 pounds thick, the stringer is 30 inches wide by 12 pounds, reduced to 8 pounds at the ends. The overhang of the main deck is supported by angle beams 4 inches by 3 inches by 6 pounds, spaced about 3 feet, having 3-inch by 2¾-inch by 6-pound Z-bar braces connected to the sheell by 10-pound brackets. The guard stringer and face plate are formed of 8-inch by 11¼-pound channels. The engine and boiler casings above the main deck are of light steel, stiffened by angle bars with the straps forming panels. The wheel battery is of similar construction.

Owing to the requirements of the trade special attention has been given to the stanchions, it being necessary to carry automobiles on the main deck in the freight space, and instead of the usual number of small stanchions, large steel I-beam girders have been fitted under the saloon deck, supported by H-bar stanchions spaced about 20 feet apart. These stanchions have been arranged to extend from the keel to the underside of the hurricane deck in one piece.

The main deck is planked with Oregon pine, having oak planksheer, the outside of the guard is fitted with a yellow pine fender and wearing piece. The supports for the saloon and hurricane deck are composed of 4-inch I-beams carried in one piece from the main deck to the hurricane deck, connected to the stringer plate by brackets. In the way of alternate stanchions on the saloon and hurricane decks are fitted steel beams of 5-inch by 6-pound channels connected to the stanchions by means of 10-pound brackets.

The saloon deck is planked with tongued and grooved Oregon pine outside of the house, and tongued and grooved maple inside, the outside planking being covered with canvas. The hurricane deck is planked with tongued and grooved redwood, covered with canvas throughout.

General Arrangement

Quarters for the chief engineer, engineers, and mates are on the starboard side forward of the wheel battery; the barroom, and colored toilets are on the port side forward of the wheel battery; the firemen and crew are berthed on the lower deck forward, and the waiters and cooks on the lower deck aft. These quarters are fitted with metal berths and lockers.

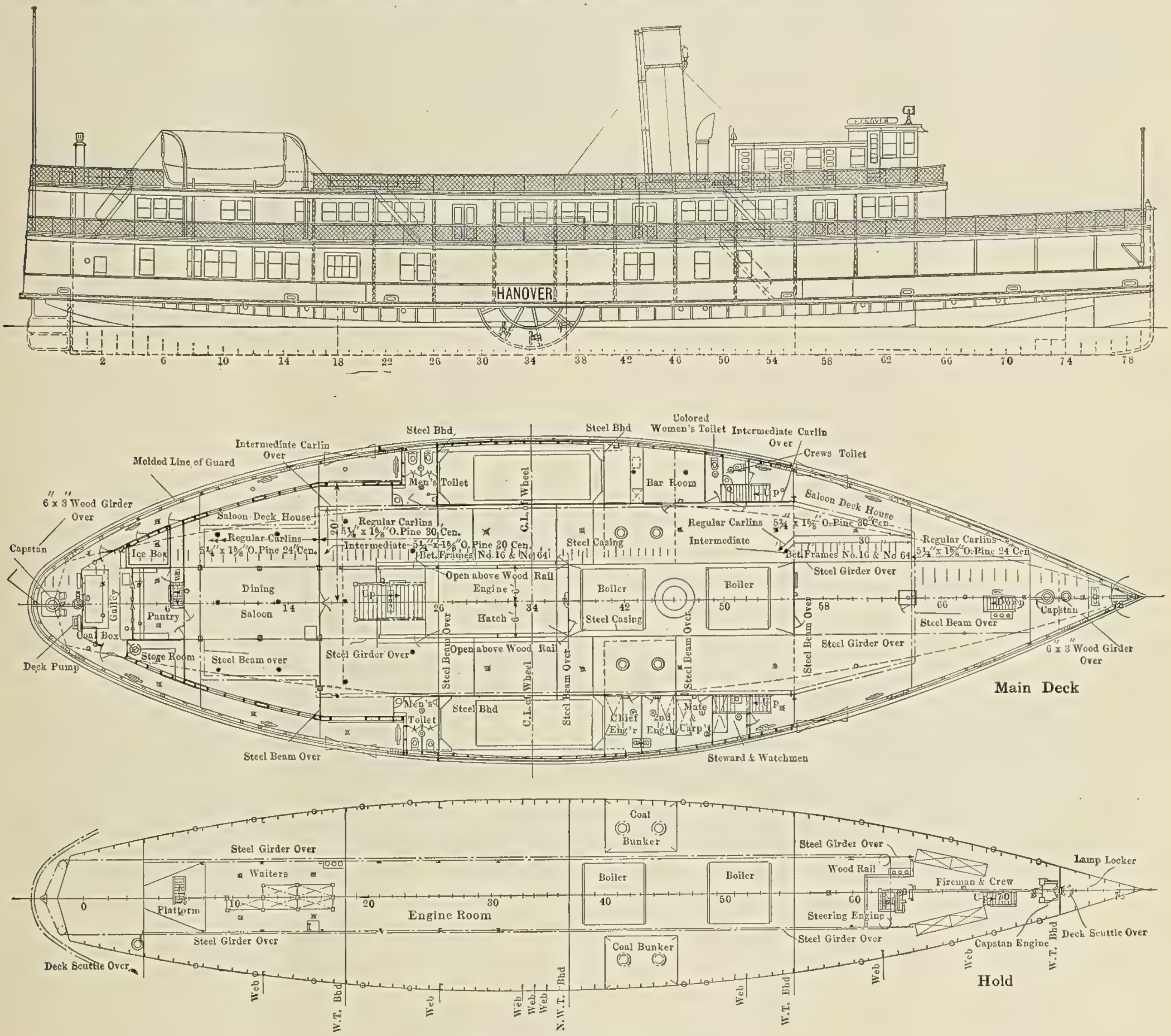
The galley is fitted at the after end of the main deck, and is enclosed with a steel bulkhead, which is a continuation of the main deck house. The floor of the galley is covered with pressed Philadelphia brick, and the bulkhead at the forward end of the galley, where it connects with the main house, is composed of "V" grooved galvanized steel. Immediately for-

ward of the galley is a large pantry with an ice box on one side and a large dry storeroom on the other.

The dining room is at the after end of this deck space, having seating accommodations for fifty people. It is attractively paneled in oak wainscoting and composite board panels above, painted white. The entrance hall to the dining room, or lobby, is paneled the same as the dining saloon, the bulkhead between the dining saloon being arranged with oak-paneled wainscoting and glass panels above. The men's

vessels is the fitting of a complete bathroom and toilet in this house for the captain's use.

The boat is equipped with lifeboats and life rafts to comply with the latest rules of the United States Supervising Inspectors. The deck auxiliaries include a steam steering gear of the Hyde make, with a 5-inch by 5-inch engine, a vertical steam capstan for handling the stockless anchor, and a 5-inch by 6-inch double engine dock capstan at the after end of the main deck abaft the house.



Profile and Deck Plans of the *Hanover*

toilets are arranged one on each side of the entrance next to the end of the wheel battery.

Forward of these accommodations the entire house on the saloon deck is open, having oak seats on the sides. The deck, as mentioned before, is of maple. This space is intended for a dance saloon, and has been arranged accordingly. The stanchions supporting the hurricane deck have been spaced about 20 feet apart with heavy I-beam girders spanning these stanchions, supporting the deck.

The hurricane deck is entirely open and has very little obstruction on it. The pilot house, captain and officers' quarters are fitted in the house at the forward end of the stack, the pilot house, captain and directors' rooms being staved with "V" jointed oak. A departure from the usual type of these

Special attention has been given to the lighting of this boat, the wiring in the crew's quarters and cargo space being in conduits with the usual fixtures. The lights in the lobby and dining saloon are of 100-watt tungsten lamps and Pyro shades, fitted in safety holders in the ceiling. The saloon deck cabin or dance hall has been lighted with the same type of fixtures and shades, having 40-watt lamps. A searchlight of the Carlisle & Finch make has been installed on the pilot house, and also a running light indicator. Every effort has been made to bring this boat up to the latest requirements, not only of the inspection service, but to meet the requirements of the trade.

The machinery will consist of two independent inclined single-cylinder engines, each driving a paddle wheel. The cylin-

ders are 25 inches diameter by 7-foot stroke, and exhaust into an independent circular surface condenser. The air and circulating pumps are independent, the former being of the vertical twin beam, and the latter of the centrifugal type, driven by a single-cylinder engine.

The wheels are of the feathering type, 18 feet 5 inches diameter over the buckets, each with nine buckets of white oak.

There are two cylindrical return fire tube boilers 10 feet 3 inches diameter by 10 feet 9 inches long, each fitted with two furnaces, the working steam pressure being 90 pounds per square inch. The boilers will be worked under natural draft. A circular superheater with corrugated flue is placed between the smokeboxes and the base of the stack, connected by copper pipes to the steam space of each boiler.

The installation of auxiliary machinery includes independent feed pumps, fire and donkey pumps, sanitary pumps for toilets, and a fresh water pump for the kitchen, etc.; the multicoil feed water heater between the feed pumps and boilers, and a feed filter tank between the hotwell and feed pumps.

Freight and Passenger Steamer Pelee

The Collingwood Shipbuilding Company, Collingwood, Ont., has just completed a handsomely modeled single screw package freight and passenger steamer, named the *Pelee*, for the Windsor and Pelee Island Steamship Company, of Amherstberg, to trade on Lake Erie, between Pelee Island and the mainland. The principal dimensions are: Length 146 feet, beam 24 feet, depth 18 feet 3 inches to promenade deck. The number of passengers for which accommodations are provided is 500.

The vessel is built of steel to the highest class in the Great Lakes Register, and has a complete steel main deck all fore and aft for the stowage of package freight, with four large gangway doors and two lumber doors at the sides. There is accommodation at the after end of this deck for the engineers, steward and purser, with lavatories and shower baths. The crew is berthed on a lower deck at the forward end of the vessel.

Above the main deck, extending the full length of the vessel, is a promenade deck, with a large deckhouse about 100 feet in length. The forward part of the deckhouse forms a commodious saloon with ample seating accommodation. The after end contains a large dining saloon, with galley and pantry adjoining.

A boat deck over the saloon deckhouse extends to the stern, forming a shelter for passengers on the promenade deck, and carrying lifeboats fully equipped, conforming to the Canadian government inspection laws. At the forward end of the boat deck is a house for the accommodation of the captain and mate, two spare staterooms, and the wheelhouse.

The vessel is driven by a triple-expansion jet-condensing engine, with cylinders 12½ inches, 21 inches and 34 inches diameter, with a common stroke of 21 inches, developing 500 indicated horsepower. Steam is supplied by a Scotch boiler 12 feet 6 inches diameter by 11 feet long. A small donkey boiler is installed for use in port when the main boiler is being cleaned.

The trials of the vessel were successfully carried out April 15, when a mean speed of 14.6 miles per hour was maintained.

Package Freight and Passenger Steamer *Pelee*, Built on the Great Lakes

An Oil-Burning Tug

One of the most completely equipped, powerful steel harbor tugs that has been put in service in New York harbor will be the new vessel just completed from designs by Messrs. Cox & Stevens, of New York City, for the Undercliff Terminal & Warehouse Company.

The principal dimensions are:

Length over all	110 feet
Length on waterline	102 feet
Molded beam	26 feet 6 inches
Molded depth	13 feet 6 inches

The contract for the construction of the vessel was awarded to J. H. Dialogue & Sons Company, of Camden, and the work was completed by the Staten Island Shipbuilding Company. In preparing the plans and specifications the architects had instructions to investigate all the existing tugs of similar size and power, the result being that they determined upon the dimensions given above, and for propulsion a compound engine, with clyinders 19 and 42 inches diameter and 30 inches stroke. Steam is supplied by a Scotch boiler, 16 feet in diameter and 11 feet in length, having four furnaces, in which oil fuel is used for firing.

The scantlings of the hull are unusually heavy; the deckhouse is of steel; and while of ample size there is sufficient clear deck at both ends of the tug for the necessary handling of the lines. The quarters for the captain are in the pilothouse, and for the engineer in the deck-house on the starboard side, handy to the engine room.

In the design of engine details unusually large bearing surfaces have been provided, and the lubrication system has been carefully worked out. The auxiliaries include a condenser, circulating pump, air pump, feed pump, donkey pump, fire pump and a feed-water heater. There is also a complete installation for electric lighting and a Williamson steam steering engine for handling the steering gear.

Questions and Answers for Marine Engineers

Inquiries of General Interest from Readers Will be Answered in This Department

CONDUCTED BY H. A. EVERETT*

Q.—Please explain the best way of working out the pitch of a propeller by measurements taken from the propeller on board ship. N. P.

A.—The accurate determination of the pitch of a propeller is usually not easy, as except for propellers with planed blade faces it varies at different points over the blade. The customary way of accurately measuring pitch is to strike on the

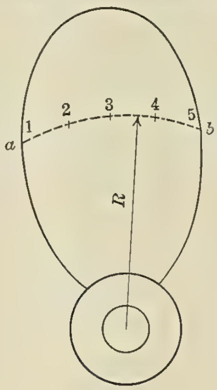


Fig. 1

face of the blade an arc of a circle, *a b* (Fig. 1), of any radius concentric with the axis of the propeller. Divide this into a number of equal intervals, as 1, 2, 3, 4, 5. Measure the developed distances of the arc on the surface of the blade and

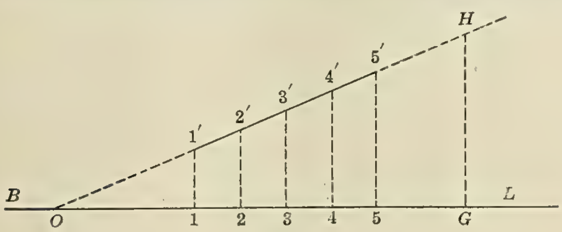


Fig. 2

lay them off on a base line *B L*, Fig. 2. Measure the distance from each point on the propeller to a plane perpendicular to the axis of the propeller, and lay these off (1-1′, 2-2′, etc.) as ordinates at 1, 2, 3, 4, 5 on the base line. Draw a line through the points 1′, 2′, etc., and produce it till it cuts the base line at

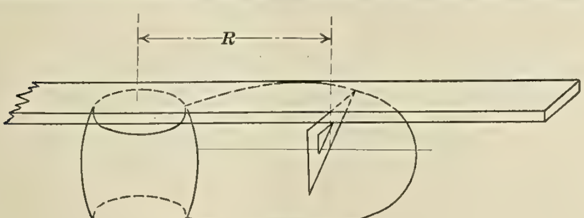


Fig. 3

O. From *O* lay off *OG* equal to the circumference of the circle of radius *R* (6.28 *R*), and at *G* erect a perpendicular till it cuts *O*-5′, extended, at *H*. *GH* is the pitch. If the pitch is uniform axially, 1′-5′ will be a straight line; if not it will be curved, in which case tangents should be drawn to each end and produced to the base line, the pitches determined for both and averaged. A careful determination of pitch requires the above procedure to be repeated for each blade and several radii on each blade.

A quick and easy method, but approximate, is to determine the radius at which the acting face of the blade (rear face) is at 45 degrees with the face of the hub. To do this, first draw a center line on the face of the blade and clamp a straight-faced plank across the rear face of the hub. Place a 45-degree triangle between the plank and blade, and move it out (always at right angles to the center line of the blade) until it fits (Fig 3). The radius from the center of the hub to this point, multiplied by 2π, or 6.28, will give the pitch approximately. This method holds only for blades of constant pitch and a pitch ratio (*P/D*) not less than 0.8.

Q.—Why is it that the inside and outside butt strapps on a Scotch marine boiler are made of the same width, while on a horizontal tubular boiler the inside strap is made wider than the outside strap? L. M. N.

A.—The majority of horizontal tubular boilers in use ashore are externally-fired boilers. In boilers of this type it is necessary to keep the thickness of the shell and butt strap to a

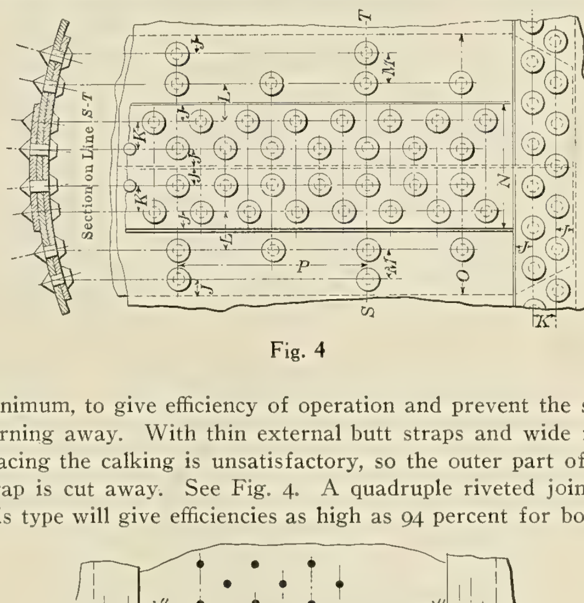


Fig. 4

minimum, to give efficiency of operation and prevent the shell burning away. With thin external butt straps and wide rivet spacing the calking is unsatisfactory, so the outer part of the strap is cut away. See Fig. 4. A quadruple riveted joint of this type will give efficiencies as high as 94 percent for boilers

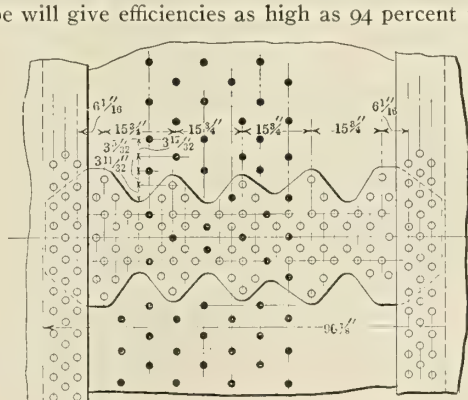


Fig. 5

whose shell does not exceed ⅝ inch, and still have a good calking pitch in the outside strap. In an internally-fired boiler of the Scotch type the shell is usually much thicker, and with the thick straps a gain in efficiency is possible by extending the outer butt strap to equal the width of the inner one without the attendant defect of a rivet pitch in the outer rows too great for satisfactory calking.

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The custom has been to use treble riveted butts with equal straps, and though the treble riveting is less efficient than quadruple it gives a spacing of the outer rivets close enough for good calking (10½ inches in a boiler whose shell is 1½ inches thick).

Occasionally quadruple riveting has been used, as in some of the large German liners, in which case the pitch of the outer rivets is too great for good calking and the straps are scalloped (see Fig. 5).

Q.—What factor is used on a crosshead guide and what effect has the length of the connecting rod on the wearing surface? M. M.

The size of the crosshead guide is determined by the dimensions of the crosshead slipper and the stroke. The crosshead slipper is usually designed so as to have a bearing pressure of about 50 to 80 pounds per square inch net area (Seaton* suggests

$$\frac{1{,}660}{\sqrt{\text{piston speed}}} + .5 = \text{allowable bearing pressure.})$$

It is customary to calculate the total pressure as follows: Assume the pistons at one-half stroke and as having the maximum

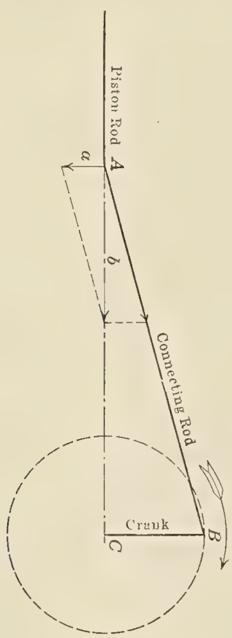


Fig. 6

effective pressure acting upon them. Let us assume that for a given case the low-pressure cylinder is 72 inches diameter (area = 4,071 square inches), and the difference in pressure is 20 pounds; then the force acting to drive the piston is 20 × 4,071 = 81,420 pounds. This force must now be resolved into two components—one along the connecting rod representing the thrust of the rod, and the other perpendicular to the guides representing the maximum load on the crosshead, which occurs when the crank is at 90 degrees (see Fig. 6). From the similar triangles, thrust of piston (b) : load on crosshead (a) : : AC : BC, the right-hand side of this proportion is a function of the ratio of the length of connecting rod to crank, and so the proportion may be written:

$$\frac{\text{thrust of piston rod}}{\text{load on crosshead}} \begin{cases} = 4.90 \text{ for ratio } \dfrac{\text{connecting rod}}{\text{crank}} = 5 \\ = 4.39 \quad \text{"} \quad \text{"} \quad = 4\tfrac{1}{2} \\ = 3.88 \quad \text{"} \quad \text{"} \quad = 4 \end{cases}$$

The commonest ratio in mercantile work is 4½, so for the case in hand:

*Seaton & Roundthwaite's Pocketbook of Marine Engineering.

$$\text{Load on crosshead} = \frac{\text{thrust of piston rod}}{4.39} = \frac{81{,}420}{4.39} = 18{,}550$$

pounds. If we accept an allowable load per square inch of surface of 73 pounds, this would give a net area of 254 square inches. Increase this by 20 percent to allow for oil grooves, etc., and we have 293 square inches. The slipper usually has a length to breadth ratio of about 4/3, so 293 = length × 3/4 length.

Length = $\sqrt{391}$ = 19.8 inches, use 20 inches by 15 inches.

The length of the guide will be the stroke, plus the length of the slipper, minus the over-travel.

If we accept an allowable pressure per square inch the expression for area of the crossread can be simplified into

$$A = \frac{\text{thrust of piston rod}}{C}.$$

C for a ratio of $\dfrac{\text{connecting rod}}{\text{crank}}$ of 4½ has the following values:

Crosshead Bearing Pressure	C
50	176
60	211
70	246
80	281

Q.—Why is the feed-water heater usually placed higher than the feed pumps? F. P. N.

A.—The feed water heater, if on the suction side of the feed pump, should be placed higher than the pump in order that the pump will prime at all times and not become air or vapor bound. Feed heaters are of two general types—surface and jet. The former may be placed upon either the suction or delivery side of the feed pump; the latter always on the suction side. In either type the steam is condensed, and the feed water raised to a temperature but little lower than that corresponding to the pressure of the steam used for the heating. If the heater were placed on the suction side of the pump, and some distance below it, the lift of the pump would so reduce the pressure on the feed water that it would reboil in the suction line, and by its vapor cause the pump to become vapor bound. Surface heaters placed upon the delivery side of the feed pump may be either above or below.

International Number of the "Shipbuilder."—The third annual International Number of the *Shipbuilder,* published by the Shipbuilder Press, Newcastle-on-Tyne, price 65 cents, has just been published. This takes the form of a resumé of all the papers devoted to shipbuilding and marine engineering which have been read during the past year before the scientific and technical institutions throughout the world. In all, the volume contains abstracts of seventy papers and upwards of 200 drawings and diagrams.

Summer Meeting of the Institution of Naval Architects.—At the summer meeting of the Institution of Naval Architects, to be held at Newcastle-on-Tyne, July 7, 8, 9 and 10, in conjunction with the Institution of Engineers and Shipbuilders in Scotland and the Northeast Coast Institution of Engineers and Shipbuilders, the following papers will be presented for discussion: Some Notes on Warships Designed and Constructed by Sir W. G. Armstrong, Whitworth & Company, Ltd., by J. R. Perrett; A Review of the Progress of the Marine Steam Engine During the Last Fifteen Years, by A. C. Ross; Charging of Two-Cycle Engines, by Professor B. Hopkinson, F. R. S.; A New Type of Internal-Combustion Engine, by H. F. Fullager; Influence of Varying Temperatures on the Strength and Other Properties of Admiralty Gunmetal, by Professors A. Campion and John G. Longbottom; The Strength of Welds by the Oxy-Acetylene Process, by Professor A. Campion and William C. Gray; Some Experiments on a Diesel Engine, by W. S. Burns.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Water Levels and Gage Cocks

Not many engineers would continue to run their boat with the boiler carrying 140 pounds pressure without being able to see the water level in that boiler. The chief engineer of a towing vessel had such an experience when the water glass broke and it was found that there were no extra ones and that the gage cocks were corroded beyond usefulness.

When everything was running normally this boiler had a habit of lifting the water and the feed pump, therefore, had to be carefully regulated. This was an advantage now and the valve that regulated the water to the pump was set for a little extra feed. The top valve on the water glass was then opened slightly and the spray from it carefully watched. If the spray appeared too wet the feed was checked and if too dry the feed was increased. Of course, since there was no superheater, a careful watch was kept to see that no water reached the engine.

As soon as possible an attempt was made to mend the water-glass temporarily by inserting the broken ends into a block of wood and thus form a fairly good union, but this proved vain, as it leaked badly. Finally the assistant engineer got three short ⅛-inch nipples and a couple of tees and screwed them together, making an overall length of about 13 or 14 inches. This took the place of the water-glass nicely and by inserting two pet cocks into the tees the arrangement was made to perform the function of the glass. The next time the boiler was washed the corroded gage-cocks were taken off and replaced, and since then there has always been a plentiful supply of water glasses aboard.

In a similar case a new man had just come on watch and had failed to locate the stops. The gage-glass broke and it took considerable nerve to go through that water and steam and grope around, and find the stops, then shut them off. Now, since that incident, on going aboard a strange boat, the first thing that man does is to locate the gage-stops.

A boiler on another vessel was equipped with a patent shut-off valve on the water line. The vessel came to dock and the engineer pumped the boiler to a level 1 inch from the top of the glass. The boat docked for about an hour and shortly after starting out the water was at the same level. Upon investigation the engineer found that the glass had broken at the top nut and of course the patent stop valves had closed, so that no noise occurred. The water was at the bottom of the glass according to the gage cocks when the break was found, and that was only 4 inches above the fusible plug, also the boiler only had a 6 inch safe working level. Gag-cocks are valuable, should be taken care of and used frequently to check the gage-glass. C.

Albany, N. Y.

Old-Time Methods

While on shore leave at Providence, the writer visited Mystic, Conn., and got into conversation with a very nice old gentleman, who had been a machinist and a fitter. In telling me about Mystic, he showed me a site where the first United States ironclad man-of-war, called the *Galena*, was built. He went on to tell of a Scotchman who turned up one day just when they started to plate the vessel. They put him to work chipping the plates. This Scotchman chipped off a strip some 22 feet long, starting from about 1/16 of an inch and ending up at about ⅜ of an inch, all in one piece. It was hung up in the office of the company as a remarkable piece of work. Then the old gentleman told me about a condenser that interested me.

He said that the heads of the condensers were made in those days of two cast plates which were riveted into the condenser shell and the holes in these plates were just through holes, not screwed as they now make them. The tubes projected through the plate and over each tube a rubber washer was forced and then a second, cast brass plate, drilled to match, was put over the tubes with studs and nuts drawn up so as to make a tight joint at each tube.

The apprentice boys punched out the rubber washers with what he called "wad-cutters" and the holes were cut smaller than the outside of the condenser tubes, so it was a hard job to force the rubber washers over the tubes. This Scotch lad looked at the boys putting on the washers, then going to the "Boss" told him he could show him a trick that would help matters. He seemed to be very handy with any tools and he went into the wood turning shop, took some old hickory handles of sledges that had been thrown away, and turned up half a dozen tapered pieces one end of which just fitted into the condenser tubes, while the other end was of the same diameter as the outside of the tubes but was tapered. He brought these back to where they were fitting up the condenser, stuck one of these pieces into a condenser tube, took a rubber washer, dipped it in water, pushed it over the wooden plug and down over the tube in about half a second. The boys had been working all the morning, trying to get the washers over the tubes, but this little trick made the job easy. Breakdown Johnny.

Cylinder Lubrication

The lubrication of cylinders of marine engines, using a surface condenser returning the water of condensation to boilers, is an important problem to be solved by the engineer. The amount of oil used in the cylinder should, of course, be the minimum required under the conditions of operation and must be ascertained by experience. Many engineers claim that oiling of the cylinder is not required at all, saying that the necessary lubrication is obtained, especially where a piston valve is used, by swabbing the rods at regular intervals. Two iron surfaces constantly rubbing each other with only the condensation of steam to depend on for lubrication, may, in some cases, work well, but just how much rubbing they will stand without evident signs of wear is hard to say and depends greatly on the alinement of the piston, rod and slides.

An engineer in charge of a large compound engine informed the writer that no oil was fed to the cylinder but that the rods were swabbed every hour. This engine had been in operation for a period of six years and during that time the cylinders had been bored twice.

Another marine engineer of long and varied experience claims that the cylinders must have lubrication of some description besides water or steam, neither of which stops wear, and when there is no lubricant there will surely be wear. This man has found that old rope, condemned from the deck, is the best and most economical material for collecting the oil from the water of condensation and has used it in his filter box for years.

Of course the oil is eliminated from the engines to save the boilers because it is cheaper to bore cylinders and occasionally fit a liner than to buy new boilers. Such conditions are common not only in practice but in design; what is of

advantage to one part may be a disadvantage to some other part of the system. A compromise then is the only logical solution for economy and efficiency.

Graphite with kerosene (paraffin), as a lubricant, has often been recommended and is used to a great extent with good results in many cases. The too frequent use of graphite tends to fill the space back of the sectional ring in the low-pressure cylinder, but no harm will result if the accumulation is cleaned out at regular intervals when rings are removed for examination. Graphite fills the pores in the liner, and if used when the engine is set up and worked into the liner is sufficient lubrication in some cases. A beam engine has been operated many years with a cylinder lubrication of one-half pint of water mixed with a teaspoonful of graphite for each seventy miles and good results are obtained. No oil is fed to this cylinder except that carried in by hourly swabbing.

Piston valves should be adjusted so that they may be slightly loose on the rod in order to find themselves free to travel true in their chambers. Many piston valves, adjusted with great care, have been found stuck to the rods with rust when removed for examination. This is probably due to lack of oil or lubricant to keep them free.

Ideas from others who have had experience or made a study of lubrication, especially with cylinders, would help greatly, as the problem is one with a large variety of solutions. Each individual case requires much thought and a complete understanding of conditions for successful operation. Isaac N. Cory.

Friction

In the May issue of this paper, under the heading of "Friction," your contributor "Ison" made several statements about the causes of friction with which I am unable to agree. I believe that the other side of this question should also be set forth in order that any of your readers who may feel so inclined may get both views without consulting some scientific work.

According to the eleventh edition of the Encyclopædia Britannica," one of the latest and best authorities on such subjects, friction "is due to the roughness of the surfaces; the minute projections upon each enter more or less into the minute depressions on the other, and when motion occurs this roughness must be either worn off, or the projections continually lifted out of the hollows into which they have fallen, or both, the resistance to motion being in either case quite perceptible and measurable." This is the generally accepted theory regarding the cause of friction.

Your correspondent quotes one of the laws of friction; that is, that "Friction is independent of the area of the surfaces in contact for any given normal pressure, etc."; and then states that "if friction were due to the interlocking of the projections, it will be seen that friction will become dependent upon the area of the bearing surfaces in contact, which is in direct opposition to the second law." It does not seem to me that this law and the theory as above given are in opposition; in fact, it seems to me that they are in exact accord. To illustrate this agreement, let us consider that the surfaces in contact are in such condition that each minute elevation of the one exactly fits into each minute depression of the other. Then, in order to make one move upon the other, neglecting possible abrasion, it will be necessary to apply sufficient force to make each minute elevation slide uphill—out of the depression in which it rests and up on to the adjacent elevation. It then slides down into the next depression, and after this repeats the whole operation as often as may be necessary to move the required distance. The operation of sliding uphill is directly dependent upon the intensity of normal pressure, which may be illustrated on a larger scale by the fact that it will take just one-half the work to move a frictionless vehicle weighing 1 ton up an incline as will be required to move a similar vehicle weighing 2 tons up the same incline. If we assume that it takes a pull of x pounds to overcome the friction caused by a load of P pounds on a bearing surface of 1 square inch, we easily see that by increasing the bearing surface to 2 square inches the intensity of normal pressure on each square inch of bearing surface is reduced to $P/2$ pounds, and, therefore, that the pull required to overcome the friction of that particular square inch is $x/2$ pounds. But we now have a bearing surface of 2 square inches, each of which requires a pull of $x/2$ pounds to overcome the friction of its surface, so that the total pull required will be two times $x/2$, or x pounds, which is the same as in the first case. The principle of this solution may be extended so as to cover almost any similar case, and it shows conclusively that the law of friction above quoted and modern theory are in strict accord with each other.

Your correspondent further states that "with interlocking projections, when one surface slides over another, we would get abrasion of the surfaces taking place, and the laws of friction would not hold good." This is exactly what happens in practice: When one surface slides over another we get abrasion, and if the surfaces are of the proper character they get smoother and smoother as the abrasion goes on. As a proof of this, just consider the condition of a smooth-running bearing immediately after adjusting and again after several weeks of wear. The laws of friction apply here, but the coefficient of friction must be modified as the characters of the surfaces change. The coefficient of friction that is applicable immediately after adjustment will be too large when the bearing is in perfect running condition.

Quoting again from the article in question, we find that "if two bodies were perfectly smooth there would still be a certain amount of resistance to sliding, hence it would seem that friction is really due to the molecular cohesion of the particles of each surface." In considering this statement we must ask whether or not it is physically possible to get two bodies with perfectly smooth surfaces. The answer must be that it is not possible, because one can hardly conceive of any substance in which the molecules are so perfectly formed and arranged as to allow a perfectly smooth surface, just as it is impossible to imagine any case in which it is possible to form a perfectly smooth surface on a barrel of apples or on a dish of beans. As the constituent parts grow smaller we approach absolute smoothness, until, when the parts become the size of molecules, we can go no farther. Needless to say, human means has never approached the limit of smoothness possible on account of the minute size of the molecule, so that all surfaces necessarily show friction when moved in contact with one another. The theory of molecular attraction is not necessary to account for the friction between seemingly smooth surfaces.

It should be remembered that the "laws" of friction are not laws in the strictest sense, but that they are little more than practical rules. They hold good, within certain limits, with sufficient accuracy for all practical purposes. They do not hold good at very high or very low speeds, or at very high pressures or very low pressures. They are affected by the length of time the surfaces have been in contact. It is well known that the so-called "friction of rest" exceeds the corresponding "friction of motion" for the same body under the same circumstances. None of these exceptions seems unreasonable when taken in connection with the theory that the friction is due to the roughness of the surfaces in contact.

That there is an attraction between different bodies is a well-established fact, but the friction due to the attraction existing between the masses of the moving parts is negligible, unless it might happen that the bodies were magnetized. This only increases the apparent normal pressure between the two bodies. W. W. B.

Marine Articles in the Engineering Press

Self-Docking Floating Dry-Docks.—The remarkable rise of the importance of floating dry-docks is commented upon. While formerly floating docks were thought suitable only for merchant vessels, they are now used most successfully for the largest battleships. In large sizes, built in the German navy up to 40,000 tons capacity, self-docking features are considered to be of the utmost importance. In turn are discussed the self-docking features of: The sectional dock with an internal width larger than the length of each section; two forms, each of three sections with sponsons; the type with two longitudinal girders and numerous small pontoons; several forms with floating side girders and internally-lifted or connected pontoons. Finally, some new constructions of three-section docks are said to contain a number of improvements for self-docking in only two operations, as well as for the possibility of riveting the sections together while partly afloat. 4 illustrations. 2,200 words.—*Schiffbau*, April 22.

Marine Oil Engines of the Dutch Navy. I.—The different requirements for the power plants of naval and merchant vessels seem to point to the desirability of the oil engine for naval vessels. Although large units still present serious obstacles, the smaller units are nowadays very serviceable as long as the fuel supply is reasonably assured. The oil engines as installed by the Dutch Navy are of the type manufactured by the M. A. N. Company, of Nuremberg. They are of the step-piston type, with the scavenging piston below the power piston, working two-cycle and single acting with six and four cylinders. The bedplates and crank cases are of bronze, securing for quick-running engines a weight of 46.2 pounds per horsepower and for slow-running engines a weight of 103.4 pounds per horsepower. Special mention is made of the very complete oil lubrication and oil piston cooling system used in these engines, and the details of the valves, valve shafts, cams and reversing gear are explained very fully. 19 illustrations, 3,600 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, April 4.

Marine Oil Engines of the Dutch Navy. II.—The machinery installations of submarine boats, small shallow-draft armored vessels, and of the boats for the East India service are described, together with some of their auxiliaries. In the armor-clads, the oil engines are too high to be placed entirely below the waterline, and are, therefore, protected by inclined armor. To guard against the total loss of compressed air, which would prevent starting the machinery, a very small auxiliary compressor and dynamo is fitted which can be started by hand. Abstracts of the trial data of several of the engines built at the works of the M. A. N. are given, as is also data covering the gradual reduction of starting pressure in a reservoir of fixed capacity by alternately reversing the engine from ahead to astern. A reservoir of about 250 gallons capacity could reverse a 600-horsepower engine about fifteen times, while one of 125 gallons could reverse about ten times. A peculiar feature discovered was that the weight of air used at each reversal gradually decreased, apparently due to the fact that each reversal needed about the same number of revolutions. All of the trials extended over several hours and one up to thirty-six hours, with an average fuel consumption normal of ½ pound of .858 specific gravity gas oil per horsepower hour. 13 illustrations. 3 tables. 1,870 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, April 11.

Warship Types of the Near Future.—Commenting editorially upon the speech of the First Lord of the Admiralty in introducing the naval estimates, it is pointed out that the superiority of the gun attack to the defense in naval construction may bring about a temporary check to the increase in dimensions of naval vessels, even if questions of deck accommodations or initial cost of units do not do so. It is suggested that the type of destroyer recently laid down is likely to develop into boats of rather smaller size, but of higher speed with much more powerful armament, to be led possibly by one or two flotilla leaders of greatest size, speed and gun power. It is also probable that the submarine will evolve into something like the light cruiser of the present day but with submersible qualities. The recent development of the seaplane and aeroplane for naval purposes might also tend to an all round increase of speed, though the ordinary attainable speed of ships is small compared with that of the aerial craft. 2,700 words.—*The Engineer*, April 3.

Torpedo Boat for the Spanish Navy.—The Sociedad Españalo de Construcción Naval was formed to undertake the carrying out of the programme as proposed for the construction of a new fleet for the Spanish Navy. The designs of torpedo boats for this fleet embody some unique features. In appearance they are like the general type of destroyer except for the fact that there is no raised deck forward, the deck line being practically straight. These boats have a length between perpendiculars of 164 feet, length over all 172 feet 5 inches, breadth extreme 17 feet 2 inches, mean draft 4 feet 10 inches and a displacement of 186 tons (metric). The propelling machinery is composed of the triple-series system of turbines, all of the Parsons type. There is a cruising and reverse turbine on the center shaft with the low-pressure turbine, the reverse being in the same casing as the low-pressure according to regular practice. The turbines are designed so that at full power the low-pressure on the center shaft develops 50 percent of the total power and the high and intermediate on the wing shafts each develop 25 percent. They are also arranged so that in case of accident to either wing shaft both can be cut off and steam admitted direct to the cruising turbine and thence to the low-pressure turbine. The two condensers are of the Normand type and have each a cooling surface of about 1,800 square feet. The center shaft is designed to turn at 1,100 revolutions per minute and the wing shafts at 1,500 revolutions per minute, giving, in a four hours' trial by the various boats with full load aboard, between 27½ and 28 knots. 1 illustration, 3 plates. 1,200 words.—*Engineering*, May 1.

Italian Scout Cruisers Marsala and Quarto.—A study of Italian warship design shows that the Italian naval authorities aim at very heavy offensive qualities, such as armament combined with the highest possible speed and the lightest possible hull. It is claimed that this idea has been carried too far with the new scouts *Marsala* and *Quarto* in that they have proved poor sea boats. The *Quarto* was laid down in Venice in November, 1909, launched in 1911 and completed for sea last year. She displaces 3,300 tons and has a length between perpendiculars of 417 feet, a beam of 42¼ feet and a mean draft of 13 feet. Propulsion is by Parsons turbines designed to develop 25,000 horsepower and it is reported that the vessel easily attained a speed of 28 knots. The *Quarto* is the third Italian ship to have Blechynden boilers installed. The armament is the same in both ships, consisting of six 4.7-inch and six 3-inch guns with two 18-inch torpedo tubes. The *Marsala* and *Nino Bixio* are somewhat larger ships, with a length between perpendiculars of 431 feet, a beam of 42½ feet, a mean draft of 13¼ feet and a displacement of 3,470 tons. Parsons turbines, designed to develop 22,500 horse-

power, are installed and steam is furnished by Blechynden boilers. 4 illustrations. 1,200 words.—*The Marine Engineer and Naval Architect,* May.

The Dutch Pilgrim and Cargo-Carrying Steamer Riouw.—The steamer *Riouw,* recently completed by Messrs. Archibald McMillan & Son, Dumbarton, to the order of the Stoonvaart Maatschappij, Nederland, Amsterdam, for pilgrim transportation and general cargo trade in the Far East, is 450 feet long between perpendiculars with a molded breadth of 55 feet 8 inches; a molded depth to upper deck of 30 feet 3 inches; a deadweight carrying capacity of 10,400 tons, a gross tonnage of 7,545, and a net tonnage of 4,755. The hull is subdivided by seven watertight bulkheads and the cargo space is divided into four large holds. The arrangements for handling cargo are very complete, including 20 steam winches and 29 steel tubular derricks, one of which is suitable for loads up to 30 tons. Propulsion is by a triple-expansion engine having cylinders 28½, 47 and 82 inches diameter by 54 inches stroke, designed to develop 5,000 horsepower. The air and condensate water pumps for the main engine are of the Mirrlees-Le Blanc rotary horizontal marine type, driven by a small De Laval steam turbine. The extraction of the air from the condenser by means of the air pump is done by water taken from and discharged back to the sea. The condensate water extraction pump, which is of the centrifugal type of special design, draws the condensate water from the condenser and delivers it to the feed filters. There is an independent De Laval feed pump system, consisting of a single-stage centrifugal pump drawing from the feed water filter and discharging into the feed heater, and a multi-stage centrifugal pump drawing from the feed heater and discharging into the boilers. Steam is discharged by six single-ended Scotch boilers, 13 feet 9 inches diameter by 12 feet long, designed for a working pressure of 213 pounds per square inch and fitted with Howden's system of forced draft. The steam is superheated by means of smoke tube superheaters made by the Ottensener Eisenwerk, A. G., Hamburg, Altona. On trial the vessel obtained a mean speed of 14½ knots. In this article an unusual amount of space is devoted to a description of the riveting of the hull; the diameter and spacing of rivets being given throughout the ship. 3 illustrations. 2,200 words.—*The Shipbuilder,* May.

The Putilow Shipyard.—The Putilow Shipyard, in St. Petersburg, Russia, is owned by a concern which has had experience in ordnance manufacture and steel construction extending over more than one hundred years. Since 1907 shipbuilding has been carried on by this company in a special department, and in 1910 a working agreement was made with the German shipyard of Blohm & Voss, Hamburg, for modernizing the shipyard and developing its equipment. Special mention is made of the installation of cranes at the building ways by the German firm Deutscher Maschinenbau, A. G., Duisburg. Brief description is also given of the building ways, the various shops and their machinery. 28 illustrations. 4,800 words.—*Schiffbau,* May 27.

Marine Indirect Drives.—This article deals with the recent tendency in marine power plant installations to break the direct connection of the driving power from the propeller by the introduction of a separate agent of transmission. Aside from mention of Foettinger hydraulic transformer, considerable space is given to the gear transmitter now frequently used with very satisfactory results on English vessels. The high efficiency of 97 to 98 percent of this type of gear, together with the great reduction in weight, space and steam consumption of the turbine, is stated to bring this arrangement of propulsive machinery commercially and financially to the level of the ordinary reciprocating engines as usually installed in medium-sized merchant vessels. The second new method of indirect drive discussed is that involving electricity, the current being generated by one or two independent non-reversible turbines or internal combustion engines, and led to one of two motors on the propeller shaft, with the necessary provision for reversing. The vessel *Tynemount* is fully described, showing the arrangement for concentrating the power of either one or both main Diesel oil driving engines upon a single large reversible alternating current motor on the propeller shaft. The special advantages derived are given as the economic adaptability of power production to power requirements, the independence and security from complete breakdown by two main engines, simple reversibility of motor and non-reversibility of the engines and the possibility of control from the bridge. The *Jupiter,* of the United States Navy, is also described, attention being directed to the great saving of weight over the corresponding plans for sister ships. 30 illustrations. 2,800 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* April 11.

Gio Ansaldo e Co.—By E. Capel Cure. This article, describing in detail the largest private enterprise in Italy, opens with an historical outline of the above firm from the time of its birth to the present day. The firm had been established by Taylor and Prandi, but in less than seven years passed to Giovanni Ansaldo, who was chosen as the instrument in a vast scheme for making industrial and economic independence in Italy march parallel with her political resurrection. The works, free of all outside influence, are now in the hands of Commendatore Pio and Mario Perrone, having been left to them by their father, Commendatore Perrone, who died on June 9, 1908. It is of interest to note that in its four works the firm employs at the present time more than 10,000 hands, and they are able to construct and equip in their own shops and by purely Italian labor a Dreadnought from keel to truck. The headquarters of the firm are located at Sampierdarena, covering an area of 904,170 square feet. Here are the offices and management, shops for machinery, case hardening, big guns, heavy turning, milling machines, machine and turbine erecting, boilers, presses, turret erecting, locomotive and tenders adjusting and erecting, small and medium gun parts, blacksmith, hoops shrinking, stores and electric generating plant and transformers. The steel works at Cornigliano Ligue is composed of iron and steel foundries, Siemens-Martin furnaces, gas furnaces for thermal treatment, and gas producers, furnace for tempering guns, rolling mills, battery of planes for armor plate, heavy and medium machine tools, directors' offices, chemical laboratory and central power station. The Sestri Ponente shipyard occupies 1,033,337 square feet and the eastern section represents a modernized form of the old yard originally built by Giovanni Ansaldo himself. This part of the yard is complete in itself. A very interesting and unique method for launching is used, which has proven successful even with boats launched ready for sea. This is quite remarkable owing to the difficulties met with, especially in the depth of water and form of bottom. The natural complement of the shipyards at Sestri Ponente is the fitting-out yard in Genoa harbor. This is made the base for trials of the vessels of the mercantile marine, and the warships make a longer stay for purposes of fitting-out. Repairs to vessels of every type are also effected here. The total area on land is 161,459 square feet and the sheet of water forming the basin 861,114 square feet. Sheds and buildings cover an area, of land portion, of 80,729 square feet. Besides a detailed description of the various shops and the work that is carried on in them, the article includes a very interesting account of the labor conditions, showing the quiet and cordial relations between employers, managers and men. 61 illustrations. 5 plates. 25,000 words.—*The Engineer,* May 8.

New Books for the Marine Engineer's Library

Ships of the United States Navy and Their Sponsors. 1797 to 1903. Compiled by Edith Wallace Benham and Anne Martin Hall. Size, 6½ by 8½ inches. Pages, 227. Numerous illustrations. Privately printed. Price, $5.

This volume has been prepared primarily for the Society of Sponsors of the United States Navy, to bring together from widely scattered and inaccessible sources obtainable facts relating to the christening of United States naval vessels. No attempt is made to give complete biographies of individuals or complete histories of vessels, but brief biographical and historical notes, giving conspicuous facts, are included for the purposes of identification and for the inspiration of every reader with patriotic pride in the achievement of the navy. Orders or communications regarding this book should be addressed to Mrs. R. T. Hall, president, Society of Sponsors of the United States Navy, the Drexel, Sixty-third street and Overbrook avenue, Philadelphia, Pa.

Marine Boiler Management and Construction. Fourth edition. By C. E. Stromeyer, M. Inst. C. E. Size, 6 by 9 inches. Pages, 405. Illustrations, 463. New York and London, 1914: Longmans, Green & Company. Price, $4 and 12/6 net.

This book, which contains one of the most complete collections of information regarding the manufacture and management of marine boilers, is typical of the author, whose broad viewpoint, covering exhaustive investigations of every subject under discussion, makes the book not only of special interest but of the utmost value. For the information of manufacturers, the troubles to be expected from the use of defective materials are discussed, as well as the dangers to which a boiler is exposed after it leaves the manufacturer's hands. For the benefit of steam users, descriptions are given as to the processes of boiler construction and also scientific inquiries regarding fuels, corrosion and similar subjects. On account of the increasing use of wrought iron and steel, instead of copper, for steam pipes, a new chapter has been added on this subject which reviews all available experiments on the losses of pressure due to friction and to radiation, explains the methods of manufacture and discusses steam pipe explosions, of which about 200 have been reported by the Board of Trade as being due either to water hammer, to inelastic arrangement, or to bad material. The question of elasticity of pipe bends has necessitated the addition of a few mathematical remarks on curved beams and a comparison with experiments on full sized pipes. High-speed tool steel, oxy-acetylene and electric welding are other subjects brought out in the present edition. The last two chapters include Lloyd's Register and Board of Trade Boiler Rules.

The Diesel or Slow-Combustion Oil Engine. By S. James Wells, Wh. Sc., and A. J. Wallis-Tayler, C. E. Size, 6 by 9 inches. Pages, 286. Illustrations, 130. London, 1914: Crosby, Lockwood and Son. Price, 7/6 net. New York, 1914: D. Van Nostrand Company. Price, $3 net.

This volume, treating specifically and fully of the design and construction of engines working on the slow-combustion system, has been prepared for use by draftsmen, students and designers. After a short historical account of the origin and development of the Diesel engine, the thermodynamics of the engine are taken up fully. The uses of the "pee-vee" and entropy diagrams are explained and problems are solved graphically by means of the heat chart. The chapter on oil fuels contains some very interesting and valuable information relating to the nature, composition and calorific values; methods of utilization; commercial value, method of transport and storage of liquid fuels. In addition to a study of balancing, some very useful notes are given relating to tests and upon the attention required when running an engine. Air compressors are dealt with thoroughly, starting from first principles. This is an important subject in Diesel engine design and one touched upon only lightly in most books on Diesel engines. The authors of this book, therefore, deserve particular credit for presenting it in such detail and in making it part of the design of the engine. Cylinders are discussed as regards strength, ratio of stroke to bore, piston speeds, and size for a given output. The formulæ for crankshafts, turning effort, based on indicator cards with hints on combining them easily, and loads on pistons and crankpins, make the book almost invaluable for designers and students. Valve gearing and inertia effects of same are dealt with in detail, showing the forces necessary to insure proper working of valves and the importance of setting injection valves, etc. Descriptions of all types of Diesel engines, both land and marine, are given and its future possibilities as a motive power in locomotives are considered. The authors have been very careful with the use of formulæ, etc., and those given are undoubtedly reliable, having been in most cases derived from first principles. An appendix (*A*) contains an abridgment of a considerable number of patents relating to the Diesel engine and an appendix (*B*) contains some useful formulæ, tables, etc. The authors have very successfully presented the subject, so that the book should be useful and invaluable to designers and students.

Lloyd's Register of American Yachts, 1914. Size, 9 by 7 inches. Pages, 513. Colored plates, 49. New York, 1914: Lloyd's Register of Shipping. Price, $7.

The new edition of Lloyd's Register of American Yachts lists a total of 3,564 yachts, 544 yacht clubs, and 36 yachting associations or other organizations connected with the sport. The old schooner *America*, which by chance did not appear in the little book of 1874, being then a vessel of the United States Navy, is still in Lloyd's, almost alone in point of age, but with her are the three defenders of the Cup which she won—*Resolute, Defiance* and *Vanitie*. Another notable new yacht is the schooner *Katoura*, owned by Robert E. Tod, designed and built by the Herreshoffs to Lloyd's rules for the International racing classes and already spoken of as a possible challenger for the America Cup in the event of the victory of the challenging Shamrock IV.

The changes of this year are, first, the passing of many wooden yachts of the Burgess era; second, the addition of new cruising yachts of larger size propelled by gasoline (petrol) engines, and third, the very large number of small raised-deck cruisers, the family launch that is meeting with such well-deserved popularity on inland as well as coastal waters.

How many yacht clubs exist today within the limits of the States, Canada and the West Indies is a question that cannot be definitely answered; the records of Lloyd's show between six and seven hundred under the varying titles of yacht, launch, power boat and motor boat clubs; many of these, small and of recent origin, are difficult to locate, but the full particulars, including location, entrance fees and dues, names of officers and address of secretary, are given for 544 clubs. The color plates include, in addition to the various national ensigns and the Signal Code and Weather Bureau flags, the burgees of 587 clubs and associations and the private signals of 1,920 yachtsmen.

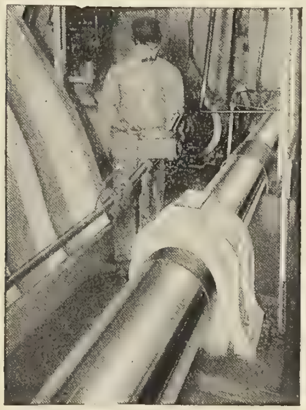
ENGINEERING SPECIALTIES

Lubrication of Tunnel Bearings

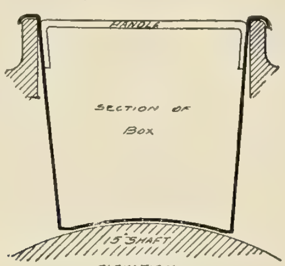
Mr. E. D. Edwards, chief engineer of the steamship *Bermudian* of the Quebec Steamship Company, plying between New York and Bermuda, has been using for the past fifteen years a method of lubricating tunnel bearings which he claims gives the best lubrication service with a minimum amount of attention and at the lowest possible cost. The lubricant used is Albany grease supplied by the Albany Lubricating Company, New York, and the method of lubricating the tunnel bearings is as follows:

The bearing caps are constructed with a large opening at the top about 8 by 5 inches and about 7 inches deep to the shaft. In this opening is inserted a grease box made of brass or galvanized iron formed to fit the opening, with a lip at the top which supports the box in position and permits the bottom of the box, which is formed to the curvature of the shaft, to rest within 1/16 inch of the shaft. The bottom of the grease box is perforated with a number of ⅛-inch holes and the grease is cut up into small chunks and placed in the bearing boxes. As the temperature of the shaft when in motion rises above the normal, it causes the grease in the bearing boxes to soften and work through the perforations to the shaft, lubricating the bearing and reducing the temperature of the shaft to normal. It is claimed that the grease which is used for this purpose will not soften and flow again into the bearing until the bearing temperature rises again, thus insuring practically automatic lubrication.

Bearing Cap



Grease Box



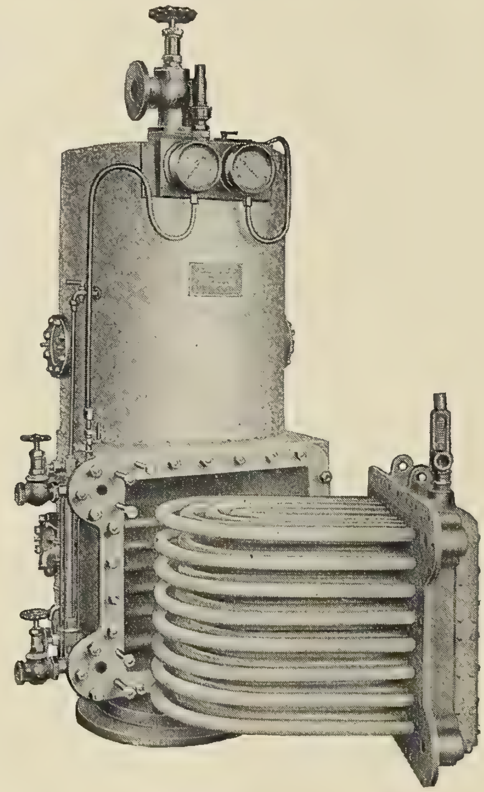
Section of Grease Box

To make sure that a constant supply of grease is always on the bottom of the grease boxes, a wooden rod is kept in each box by means of which the grease is worked down by the oilers on their regular rounds. Each bearing box holds about two pounds of grease, and about forty pounds of grease are consumed in the tunnel bearings each trip, which lasts about forty or forty-five hours, according to weather conditions.

Schutte & Koerting Evaporators

The Schutte & Koerting Company, Philadelphia, Pa., has on the market a vertical navy type evaporator consisting essentially of an upper and lower body. The upper body is the vapor chamber and the lower body contains a nest of tubes or coils comprising the heating surface through which the steam is circulated. Each coil is arranged to thoroughly drain itself, all drainage finally being taken out through the bottom set of coils. This arrangement, it is claimed, eliminates the choking of the coils.

An important feature of this evaporator is the method of preventing priming. Priming is caused by the formation of large air bubbles and by the vapor holding water in suspension. Ordinarily, this can be overcome by the use of a long vertical vapor pipe of large diameter, but the Schutte & Koerting evaporator has a special baffle plate arrangement in the vapor chamber which collects the water in suspension, thus eliminating, it is claimed, the possibility of priming.

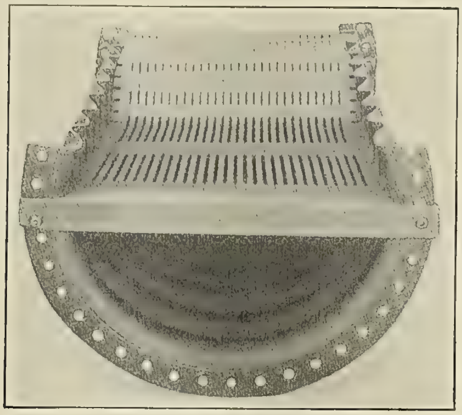


According to the requirements, the lower body of the evaporator is of cast iron, or bronze, and the upper body, or vapor chamber, of sheet brass, copper, cast iron or steel. Particular care has been taken in the design of the fittings. When removing the tubes for cleaning, no steam joints need be broken and the tubes are so arranged that they may be easily scaled. The weight and space occupied by these evaporators have been reduced to a minimum, as is shown by the fact that an evaporator with a capacity of 20 tons per day is only 7 feet high, occupying a floor space 3 feet 10 inches by 3 feet 5 inches.

The Von Riegen Patent Firebridge Bar

The Von Riegen firebridge bar, illustrated, has been designed to improve the combustion of fuel in Scotch boilers and to do away with the troubles commonly experienced with the ordinary grate and bridge. The title "firebridge bar" has been given to this arrangement because when all the bars are placed in the grate they form the firebridge by means of their rear hook-shaped ends resting upon a thickened ledge or

flange on a partition which closes the ash pit. The forward ends of the bars are freely suspended from cross-beams. Each firebar is provided on its rear upwardly bent end with lugs by means of which the bars mutually support each other. The lugs also form passages between the bars for the circulation of air. The partition which closes the ash pit toward



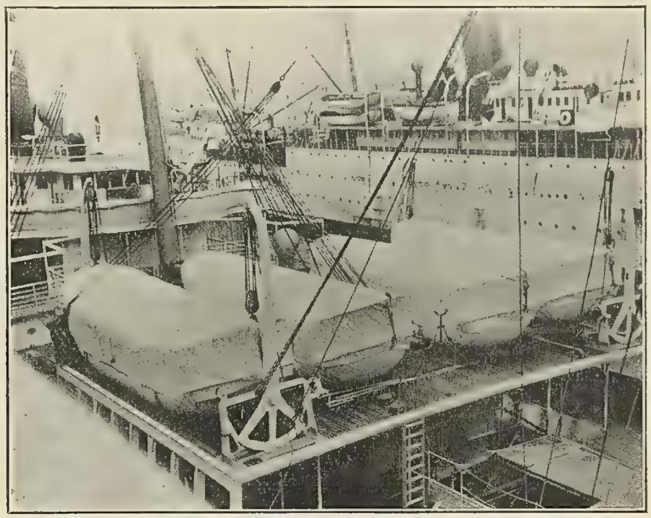
the rear consists of two parts with pieces laid in—an arrangement which facilitates varying the height of the firebridge according to the nature of the fuel used. In the lower part of this partition a hole with a small door is provided for purposes of cleaning. As shown by the illustration, all brick work is dispensed with, so that the bars can easily be placed in position, allowing speedy repairs. Another advantage is that the fires can be cleaned at sea in a comparatively short time, thus reducing fluctuations of steam pressures to a minimum. It is also claimed that clinker does not adhere to this structure as it does to brick work, and that the firebridge bar will not become choked up with slag and ashes.

The patents for the Von Riegen firebridge bar are controlled by Paul Pajewski, Hamburg 30, Eidelstedterweg 8, Germany.

New Arrangement of Lifeboats on the U. S. Transports

When the question of fitting out the United States transport ships with adequate lifeboats for all on board came up, the government called for demonstrations of apparatus and arrangements, and in October, 1912, utilized the transport *Kilpatrick* at Newport News for carrying out tests of the various types of boats and davits. As a result of these tests the Welin Marine Equipment Company, of Long Island City, N. Y., received an order for Lundin decked lifeboats with complete Welin davits and fittings, sufficient to carry 10,200 persons, which means about one hundred and seventy-six boats.

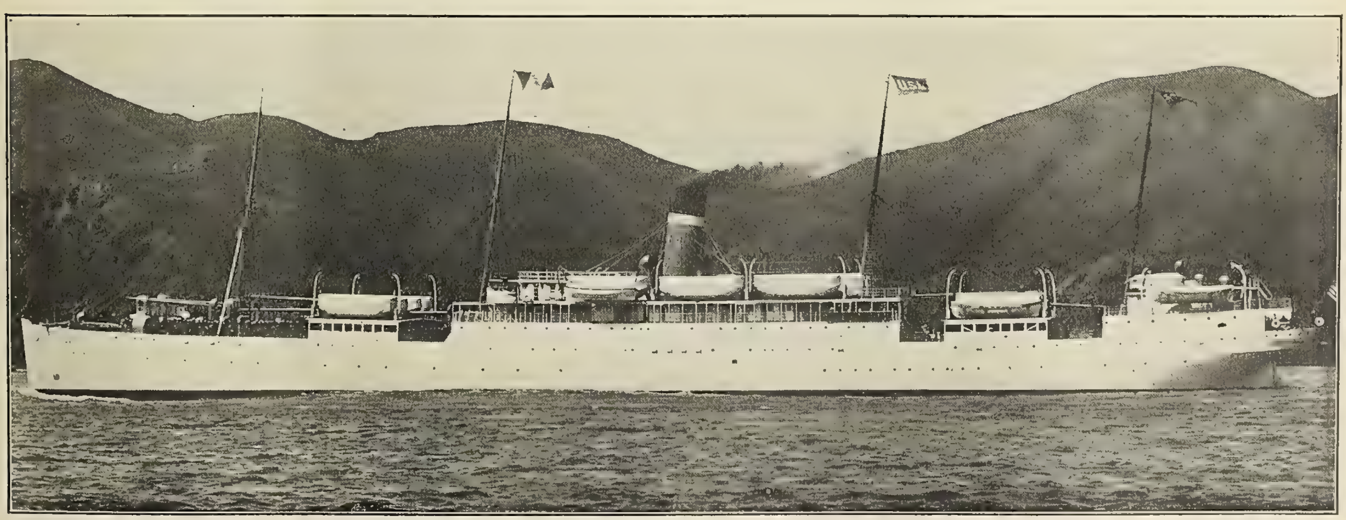
The *Kilpatrick* was the first of the fleet of nine United States army transport ships to be equipped with her new



Eight Lundin-Decked Lifeboats Nested on the Skids of the *Sheridan*

complement of lifeboats. She was on the Atlantic coast, and the work of installation was done at the Morse Dry Dock Company, Brooklyn, N. Y. The *Sheridan*, shown in Fig. 1, is the second, the work being done at the Union Iron Works, San Francisco, where the *Logan* is now being similarly fitted out. As now fitted, the *Sheridan* has a lifeboat capacity for 2,100 persons, and as her maximum capacity for passengers and crew is 2,069, she has an actual excess of thirty-one provided for in the boats and rafts.

The compactness with which these boats are stowed is shown in the view of the decked-over skids, built across the ship from rail to rail, just forward and aft of her bridge deck. On the forward one are stowed eight 28-foot Lundin decked lifeboats "nested" two deep, under two pairs of double-acting Welin quadrant davits. This one group of boats will safely carry 480 persons. As shown in Fig. 2 the davits reach inboard far enough to stow the boats on the inner tier as well as deposit them in the water well outside the side of the ship.

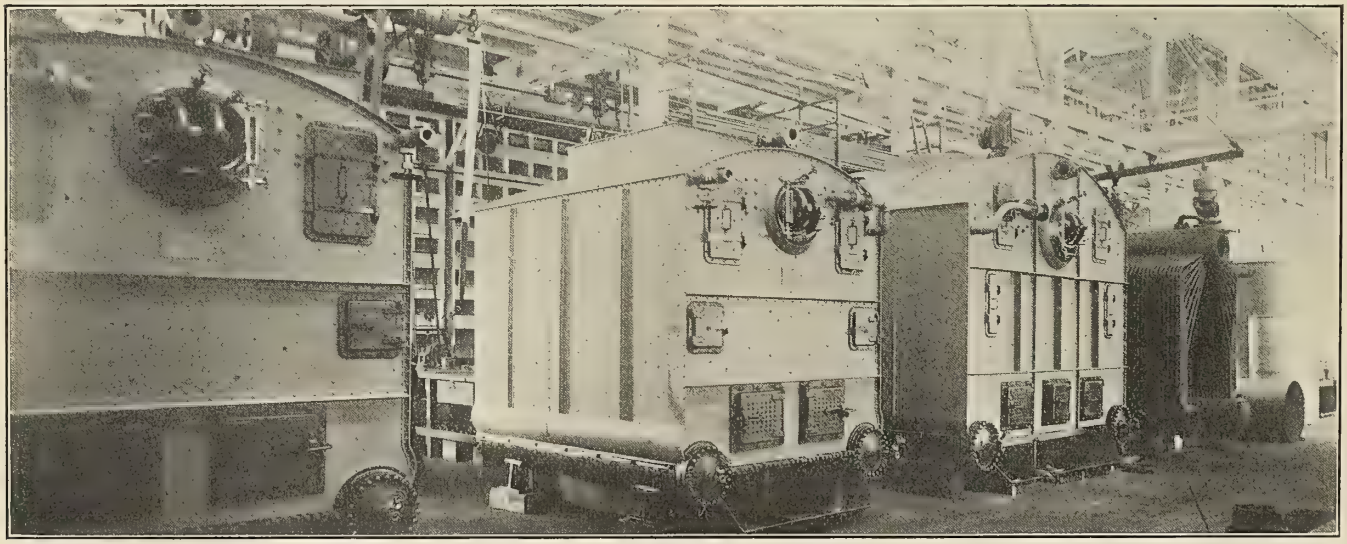


U. S. Army Transport *Sheridan*, With Her New Outfit of Small Boats

An Economic Way to Handle Shipments of Long Iron Rods

The recent installation of a Shaw electric crane at the plant of the Bayonne Bolt & Nut Company, of Bayonne, N. J., is an important illustration of the manner in which one problem of handling material was solved by the application of a few small strands of wire. The Bayonne Bolt & Nut Company receives quantities of bar stock-iron rods about 20 feet in length, and ranging in diameter from ¼ inch upward. This raw material comes in gondola cars on the company's private switches. The unloading and stacking of the rods by hand was, however, a slow and expensive process.

In seeking a better way to do the work an electric crane and magnet was installed by the Shaw Electric Crane Company, of New York, and by wiring the rods together in bundles of approximately a dozen, it was possible for the magnet to make a clean lift, not merely of one bundle, but of a number of bundles up to its lifting capacity. With the crane and magnet, work can now be accomplished in a few minutes which under the old method took a gang of freight handlers hours to do, and the rods can be piled to a greater height than would have been economically possible by hand work.



New Seabury Boilers

In the construction of the Seabury marine watertube boiler, manufactured by the Gas Engine and Power Company and Charles L. Seabury and Company, Consolidated, Morris Heights, New York City, four of which are shown in the course of construction in the accompanying illustration, the steam drum consists of a tested steel plate of 60,000 pounds tensile strength, rolled up and double riveted with bumped heads of tested material riveted in. The two mud drums are usually constructed of lap-welded steel tubing, having flanges riveted to each end, to which cast steel covers are secured by means of studs. The steam and mud drums are then accurately drilled with jigs for tube holes. The tubing, of which the greater portion of the heating surface consists, is of seamless drawn steel, expanded into the holes in the steam and mud drums, there being no screw joints subjected to the intense heat in the combustion chamber. The tubes are so bent and arranged as to leave ample passage for the gases, as well as to provide necessary baffling and allow for expansion and contraction.

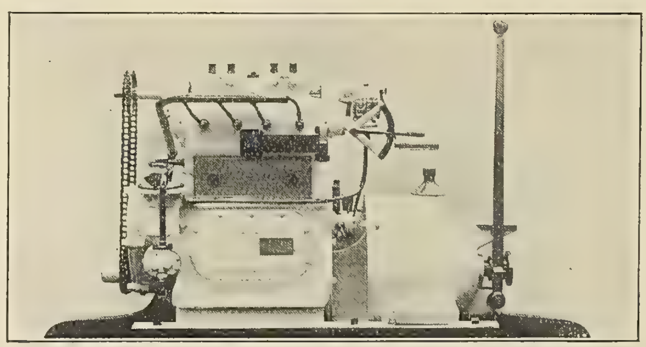
Over the nests of tubes on both sides of the steam drum is located a feed water heater, through which the water passes before entering the drum. The heater is constructed of steel piping and malleable iron return bends, and between the heater and drum is interposed a check valve. The boiler is cased in a substantial sheet steel jacket, stiffened with angles and lined on the inside with magnesia and asbestos, except the ends of the combustion chambers, which are lined with fire brick. The casing is fitted with all necessary fire and cleaning doors.

The shaking grates with which all Seabury (anthracite) coal burning boilers are equipped are an important feature in their design. They consist of square steel bars running lengthwise of the boiler, carried on cast iron bearers; these bars extend through the boiler front, where they can be conveniently shaken. Cast iron grate bars in sections are fitted, when it is desired to burn soft coal

Owing to its large combustion chamber the Seabury boiler is well adapted for the burning of fuel oil and any of the many successful systems now on the market can be readily applied.

New Thornycroft Marine Motor Type "T"

Messrs. John I. Thornycroft & Company, Limited, Southampton, recently exhibited at the aero and marine motor exhibition a new type kerosene (paraffin) and gasoline (petrol) motor which will be known as their "T" type. The new type has been placed on the market to meet the requirements of a moderate weight, compact four-cylinder high speed



motor, suitable for installing in fast craft up to 30 feet in length. The four cylinders, which are cast monobloc, are 3½-inch bore by 5½-inch stroke and the powers developed at about 1,100 revolutions per minute are 18 brake horsepower on kerosene (paraffin) and 22 brake horsepower on gasoline (petrol). Some special features in this new type are worthy of note; all the valve gear is enclosed by a casing over springs, etc., being instantaneously removable. A large crank-case door gives easy and ready access to the main bearings. Lubrication

is on the trough system, the oil being fed to the troughs by means of a small gear pump. A large glass indicator is fitted in a prominent position, enabling the proper circulation of the oil to be readily seen. The reverse gear is of the epicyclic type, the ahead cone being combined with the flywheel, thus forming a single unit. This method is to be recommended, for when installing the difficulties of correct lining up are much reduced. The ignition is by high tension magneto. For running on kerosene (paraffin) a vaporizer of Messrs. Thornycroft's latest approved type is fitted and starting can be effected by running on gasoline (petrol) for about three minutes, after which the kerosene (paraffin) can be turned on. If, however, gasoline (petrol) is not available a blow lamp can be used to heat the vaporizer, and starting is effected from cold in about three minutes. The control is by a single lever, which operates on the governor.

Personal

Thomas J. Riley has been appointed chief engineer of the steamer *William* of the New Haven Towing Company, New Haven, Conn.

Mr. Carels, one of the founders of the firm of Carels Freres, Diesel engine builders, died April 27th, at Ghent, Belgium, aged seventy-five.

Louis Purdy, formerly of the *Pawnee*, has been appointed chief engineer of the *Pentland*, plying between Lakes Superior and Erie in the lumber trade.

Samuel Shoemaker has become assistant to Stanley Raynes on the steamer *Oscar Barrett*, owned by the Barrett Tow Boat Company, Cairo, Ill.

David A. Black has been appointed chief engineer of the steamer *City of Toledo* of the White Star Line, running between Port Huron and Detroit, Mich.

Frank Good has been appointed chief engineer of the harbor tug *Alice Cooper*, owned by the Monongahela River Coal Company, and operated on the Ohio River.

William F. Shanks has been appointed by the owner, Captain Harry Davis, as chief engineer of the excursion steamer *Golden Fleece*, at Cairo, Ill., vice John Owing.

Edward Helling, a well-known marine engineer of Paducah, Ky., is the guest of Horace Armstrong, chief engineer of the tug *Susie Hazard* at St. Louis, Mo.

George B. Van Allen will be chief engineer and Captain Percy Wolfe will have charge of the *Robert Duy*, of Albany, N. Y., which has been rebuilt for use on State work.

William Hurst has recently shipped as assistant engineer to E. Cropper on the steamer *Enterprise*, owned by the M. R. C. C. Co. and used for towing purposes in the Ohio River.

James W. Francis, chief engineer of the tug *Florence W.* of the J. P. Randerson Dredging Company, was seriously injured by being caught in the thrust-bearing coupling on the tug.

O. J. Fish, secretary of the American Shipbuilding Company, Cleveland, Ohio, has been elected treasurer to succeed Russel C. Whetmore, deceased. Mr. Fish will occupy both positions.

Edward C. Morgan has recently been appointed engineer with Malvin C. Preston, chief engineer, on the steamer *Elm City*, of the Long Island Navigation Company, at West Haven, Conn.

Joseph P. Brady, of Washington, D. C., is chief engineer of the steamer *General E. O. C. Ord*, used by the government for mine planting. George M. Crocke, of New York, is his first assistant.

Peter Dietz has been appointed chief engineer of the steamer *Yosephee*, recently chartered by the government to work at Albany, N. Y. Captain Albert Hotaling will have charge of the steamer.

Archibald Bryce, now chief engineer of the *Aquitania*, joined the Cunard Line as a junior engineer in 1884. Last year Mr. Bryce, who is a native of Liverpool, was chief engineer of the *Lusitania*.

Robert B. Wallace, one of the best known marine engineers on the Great Lakes, has resigned as general manager of the American Shipbuilding Company, Cleveland, Ohio, a position which he has held since 1908.

Chief Engineer William C. Claflin and Captain George McCabe, formerly of the Albany Towing Company, have received appointments on the tug *Chester* for the J. P. Randerson Dredging Company, Albany, N. Y.

The passenger steamer *Thomas S. Craig* has been converted into a towing vessel for runs between Albany and Parr Island and named after the captain in charge, M. W. Hill. The captain's son, Walter B. Hill, will be the engineer.

Richard Ward Baker, identified with the Watson-Stillman Company, of Aldene, N. J., and New York City, since 1864, has just been paid fitting recognition for his fifty years of service in that company by the presentation of a handsome gift.

John Carey, formerly first assistant engineer of the steamer *C. W. Morse* of the Hudson Navigation Company, New York, has been appointed chief engineer of the *Kintch* of the Great Lakes Dredging and Dock Construction Company. Captain M. E. Fallon will be in charge of the *Kintch*.

Alfred G. Smith has been elected general manager of the American Shipbuilding Company, with headquarters at Cleveland, Ohio. Mr. Smith was general superintendent of the Chicago Shipbuilding Company for six years and a practicing naval architect for about the same length of time.

George T. Cahill was recently transferred to the tug *George E. Lattimer* as chief engineer. In charge of Captain George Barnard, this tug made a trip to Palmyra, N. Y., for a fleet of pontoons and houseboats in charge of Captain Charles Scanlan, for the Great Lakes Construction Company.

Naval Constructor H. A. Evans, a graduate of the Naval Academy at Annapolis of the class of '92, who, after completing his sea service, was sent to the University of Glasgow, Scotland, for a special course in shipbuilding and designing, has recently been elected vice-president and general manager of the Skinner Shipbuilding and Dry Dock Company, Baltimore, Md.

C. J. Tenneson has been appointed chief engineer of the steamer *Frederick Du Barry*, owned by the Potomac & Chesapeake Steamboat Company, Washington, D. C., to fill the vacancy caused by the death of Albert Geen, whose appointment to the position of chief engineer of this vessel was announced in our last issue.

B. O'Donnell has been appointed chief engineer of the steamer *Angler*, plying on the Potomac River from Washington, D. C., to Riverview, Md. Mr. Dugan is assistant engineer on the *Angler*.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

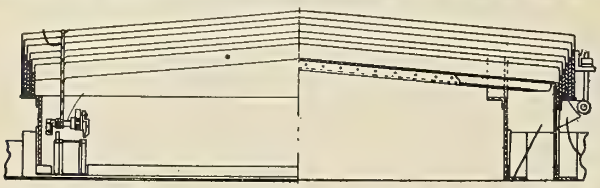
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millertown, N. Y.

1,093,159. TURBO SHIP-STEADYING DEVICE. ELIHU THOMSON, OF SWAMPSCOTT, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

Claim 8.—A gyroscopic anti-rolling device for ships, comprising a vertical shaft turbo-generator having a condenser base and mounted to swing in a fore-and-aft plane, a tank in which said base is submerged, means for supplying said tank with cooling water, and a plate on said condenser base dividing said tank into two compartments on the plane of the axis on which the machine swings. Eleven claims.

1,072,611. WATERTIGHT HATCH FOR BOATS. WILLISON H. HAYES, OF TOLEDO, OHIO.

Claim 1.—A hatch cover comprising a series of collapsible sections adapted to be extended to cover hatch opening and drainage means for



the joints between adjacent sections permitting of the collapsing of same. Twelve claims.

1,094,005. LOAD-TRANSFER APPARATUS. THOMAS SPENCER MILLER, OF SOUTH ORANGE, N. J.

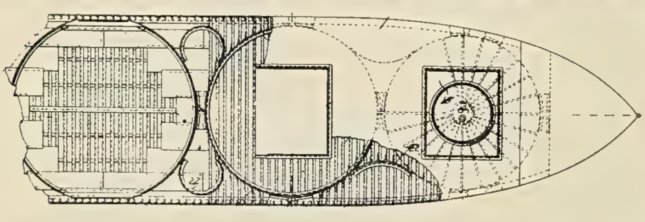
Claim 1.—In a load-transfer apparatus, a support, a swinging rope supported therefrom and having a rope guide, a combined hoisting and swinger rope guided by said guide, and a rope opposing the pull on the hoisting rope. Seventeen claims.

1,094,963. MECHANISM FOR FIRING TORPEDOES. THEODORUS S. BAILEY, OF QUINCY, MASS.

Claim 2.—A torpedo tube installation comprising a plurality of tubes having tube opening mechanism and firing mechanism associated therewith, in combination with a firing control device common to a plurality of the firing mechanisms and connections between the tube, opening mechanism and said firing conrtol device, such that the actuation of the tube opening mechanism automatically connects the firing control to the open tube; substantially as described. Ten claims.

1,085,086. TANK VESSEL. CHARLES P. M. JACK, OF NEW YORK, N. Y., ASSIGNOR TO THE INTEROCEAN TRANSPORT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF SOUTH DAKOTA.

Claim 1.—A tank vessel comprising a hull, and a vertical tank forming a part of the structure of the vessel the sides of the tank being



formed by semi-circular bulkheads directly connected to the sides of the hull. Eight claims

1,090,923. LIFEBOAT. LAURITS OLUF LARSEN, OF PERTH AMBOY, N. J.

Claim 1.—In a collapsible lifeboat comprising longitudinal ribs and cross ribs adapted to interlock therewith, friction fingers carried by said longitudinal ribs for releasable engagement with said cross ribs, pins carried by said longitudinal ribs for releasable engagement with the terminations of said cross ribs and yieldable locking means carried by said longitudinal ribs for engagement with said pins to retain them in operative position. Two claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

18567/1912. PONTOON FOR LIFTING SUNKEN VESSELS. B. JOURAVLEFF, LIEUTENANT, MARINE ENGINEER CORPS, ST. PETERSBURG, RUSSIA.

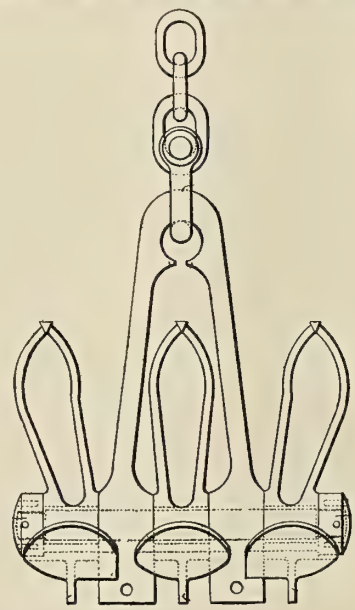
Relates to improved means for use in lifting sunken vessels, including a pontoon provided with a chamber permanently filled with air to give buoyancy, and adapted to be submerged by flooding and to be lowered towards the sunken vessel through the intermediary of guide ropes connected to the sunken vessel and wound around drums of pneumaitc winches fitted on the pontoon, which serve merely to wind up the guiding lines in lowering the pontoon.

21,409/1912. IMPROVEMENTS IN NAVIGATIONAL SOUNDING APPARATUS. KELVIN & JAMES WHITE, LIMITED, 16, 18 AND 20 CAMBRIDGE STREET, GLASGOW.

Navigational sounding apparatus comprises, according to this invention, a sheath or bell open for passage of water at one end, and a prepared tube open at both ends and resiliently enclosed in the sheath or bell, this tube being adapted on emersion of the bell to indicate by the action of water on its inner surface the height to which the wate has risen in the bell around the tube, when immersed. A chemically coated tube, which in uses is open at both ends and which is closed till required for use by destructible capsules, is employed in the apparatus.

9,710/1913. IMPROVEMENTS IN STOCKLESS ANCHORS AND IN HOUSINGS THEREFOR. A. F. W. STAHLBERGER, OF 2 TAYLOR STREET, WHITECROOK, CLYDEBANK, DUMBARTONSHIRE.

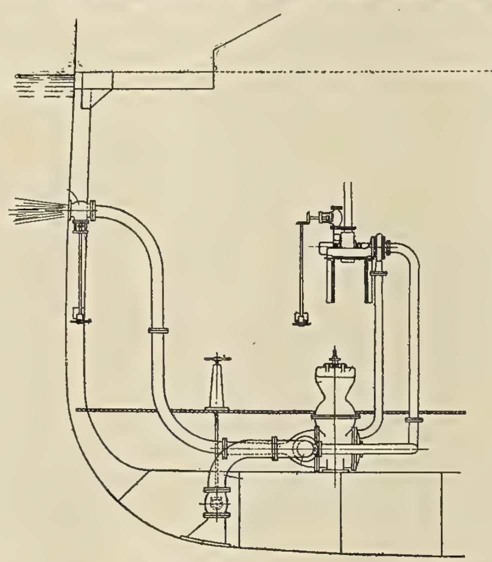
An improved stockless anchor is formed with a bifurcated or triangulated shank and provided with three similar main gripping fluke members, one pivoted between the bifurcations and one pivoted at either



side of the shank, which, at its upper end, is rounded to receive the usual shackle or link. A housing for use with the anchor has a curved base triangular in plan and flush with the ship's structure, and is provided with a curved cover-part, in which is a hawse hole and a fairlead.

3,176/1913. ASH EJECTORS FOR SHIPS. G. & J. WEIR, LTD., HOLM FOUNDRY, CATHCART, GLASGOW, AND J. PETERMOLLER.

Comprises an arrangement and construction of ash ejector, according to which a hopper, into which the ashes can be shoveled, is arranged so that the ashes can gravitate (*i. e.*, move solely by gravity) from this hopper into a discharge nozzle, through which they are driven by a



high-velocity water jet playing into and through this discharge nozzle into the eduction pipe, through which circulates, at a relatively low velocity, a quantity of water which fills the pipe, and is large compared with the quantity which constitutes the jet water. The delivery end of the nozzle is arranged co-axially within the eduction pipe.

27,296/1912. IMPROVED INSTALLATION FOR EJECTION OF ASHES FROM SHIPS. J. MEIKLE, OF MARYHILL, GLASGOW.

An installation for the ejection of ashes, etc., from ships, comprises one or more collectors each provided with a valve-controlled inlet passage leading from the sea and with a valve-controlled discharge passage leading to the sea at a point below the connection of the first passage with the sea, and a helical conveyor for conveying the ashes, etc., to the discharge passage of the collector.

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The Construction of Steel River Barges

General Types of River Barges for Transportation of Bulk and Package Freight—Details of Construction

In the development of water-borne traffic on the inland waterways of the United States, three essential requirements must be met: First, there must be a sufficient stage of water; second, there must be ample terminal facilities, and, third, there must be suitable craft. When the foregoing essentials are supplied, freight in satisfactory volume will find its way to the rivers.

Through the splendid work of the Engineer Corps of the United States army the first condition is being met by the United States Government as rapidly as the appropriations by Congress will permit. Especial attention has been given to the canalization of the Ohio, Missouri and Mississippi Rivers, while many other streams are being improved by dredging and by the protection of banks, etc. New canals are being built and others reconstructed, the largest single project of this character being the New York State Barge Canal. On the Southern rivers the development of water transportation has been greatly stimulated by the completion of the Panama Canal, and with this development there has naturally come an awakened interest in the construction of terminals for the rapid and economic handling of freight in bulk and package, and, linked with this, the interchange of freight between railroads and river lines by means of through bills of lading,

Interesting as are the developments which have been made, and which must be made in future, to meet the first two requirements for river transportation, nevertheless it is the third requirement—the provision of suitable craft—which is of immediate interest to shipbuilders and transportation officials. It is this phase of the problem with which we propose to deal in this article.

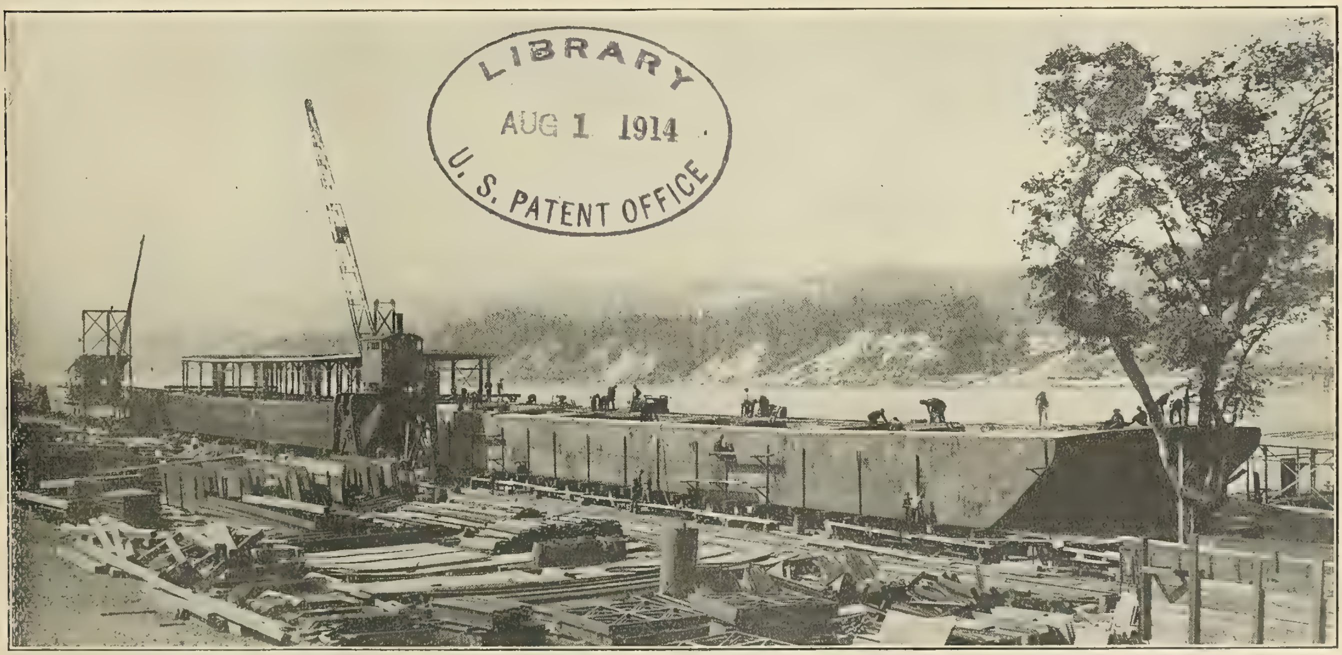


Fig. 1.—Shipyard at Ambridge, Pa., Showing Locomotive Gantry Cranes

In the early days lumber was the material naturally used for the construction of river barges, both because it was usually available close at hand, and because its first cost was low with interest charges correspondingly so. The costs of maintenance and repairs, however, were high. Gradually good timber for barge construction became more and more scarce, until now it is almost unobtainable at satisfactory prices or of suitable quality. For this reason, and also due to the fact that improved river conditions and improved terminal facilities demand that barges and river craft shall be of more permanent and stable construction, the transition to steel has been naturally brought about.

Steel river barges were used successfully about ten years ago, although the first cost was then, as it is now, higher than that for wood construction, nevertheless the largely increased life of the craft, the reduced cost of maintenance, the lower operating expenses and the minimum cost for repairs, brought the ultimate cost of steel craft to a figure considerably lower than that for wood. Added to this is the very much decreased cost of insurance, not only for the craft but for the cargo, for insurance rates are now prohibitive on first-class freight in wooden barges, whereas they are extremely low for such freight when carried in well-constructed steel barges.

Fig. 2.—Steel Cargo Box Barge

To show the general features of design and construction which have been developed in recent years in the building of steel river barges for various purposes, we have secured some data from the American Bridge Company, Pittsburg, Pa., regarding the steel barges built recently at their barge and boat yard at Ambridge, Pa.

The Ambridge Shipyard

This yard, which is a department of one of the largest bridge and structural shops in the world, is located 16 miles west of Pittsburg, on the Ohio River. On account of its close proximity to the steel mills, and because most of the tonnage on the Mississippi River comes from this locality, the barge yard is ideally located for the manufacture of river craft. We use the term "manufacture" advisedly, as the material is punched, riveted and otherwise prepared by the best and most approved machinery before it is assembled. By punching the plates with spacing punches, the rivet holes are perfectly alined, and the work of assembling, fitting and riveting is rapidly carried out. The material, which is fabricated in the large shops of the American Bridge Company, is delivered to the barge yard on railway cars, from which it is unloaded and stored and assembled by locomotive cranes of the gantry type, two of which are shown in the general view of the yard, Fig. 1. The barges are built on the steep bank of the river, and are launched according to Lake methods—sidewise from ways parallel to the river bank.

At this yard barges have been constructed for the United States Government for use in the improvement of the Ohio and Mississippi Rivers. Barges have also been built for transporting general merchandise or packet freight and for the transportation of such bulk cargoes as coal, sand, bulk oil, steel products and cotton. In addition, the output of the yard has included a number of car floats and the steel hulls for towboats, packets, dredges and pile drivers.

Box Barge for General Cargo

Fig. 3 shows the general construction and arrangement of a cargo box barge 200 feet long by 36 feet beam, with a depth of 10 feet 6 inches, eleven of which have been built in the last few years at this plant for the American Steel & Wire Company. The barges are used for carrying steel products of the subsidiary companies of the United States Steel Corporation

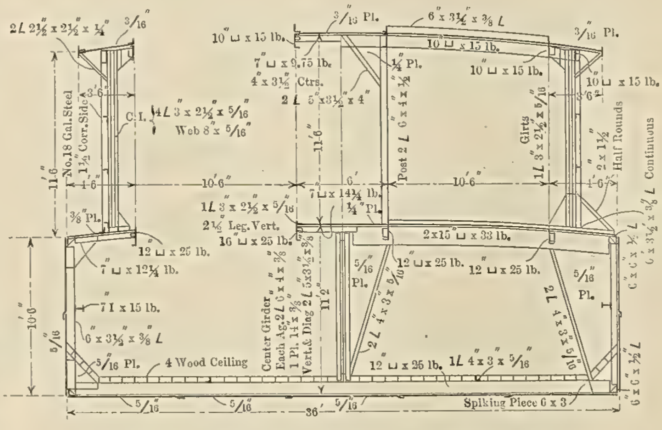


Fig. 4.—Midship Section of Cargo Box Barge

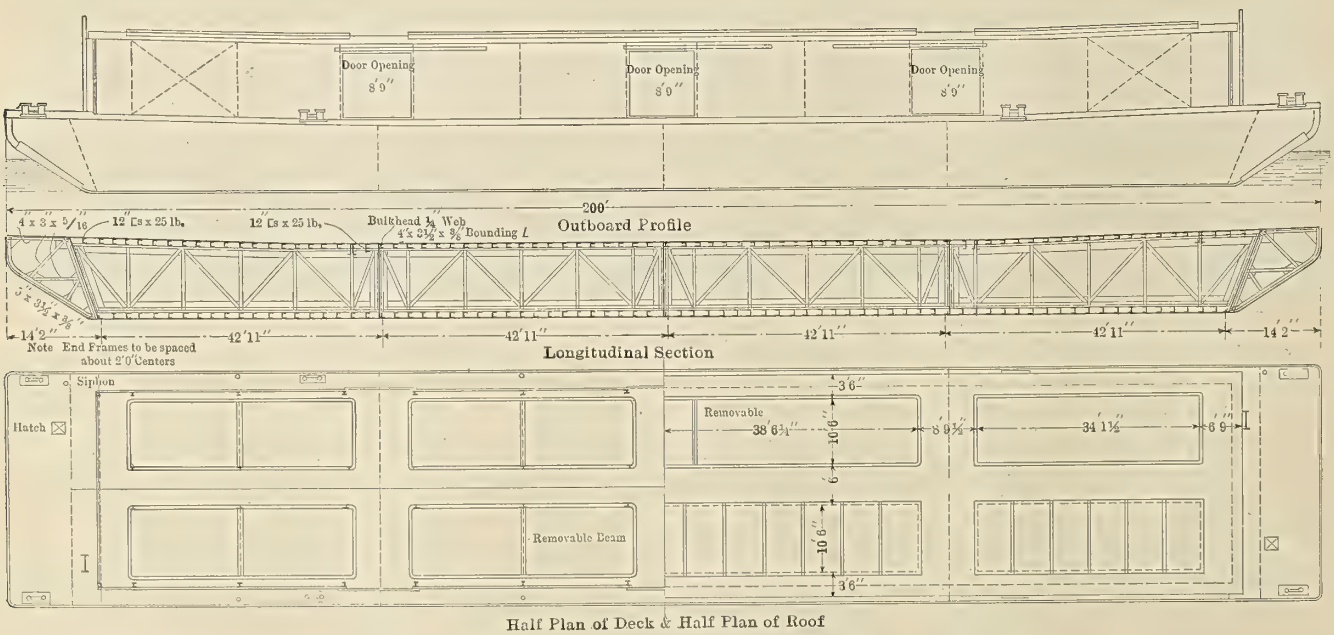


Fig. 3.—Profile, Longitudinal Section and Deck Plan of 200-Foot Cargo Box Barge

Fig. 5.—Barge Built for the Kansas City-Missouri River Navigation Company for the Transportation of Miscellaneous Freight

from the Pittsburg district to ports on the Ohio and Mississippi Rivers. The general construction of these barges is clearly shown by the photograph and drawings. The cargo box, which is 180 feet long, 31 feet wide and 11½ feet high, was necessary to give sufficient cubical capacity when carrying the lighter products, such as field fencing, barb wire, etc. Hatches were placed in the upper deck to permit the use of cranes in loading and unloading. These barges have a cargo-carrying capacity of 1,500 net tons on a draft of 9 feet.

Fig. 5 shows one of three barges which were completed last year for the Kansas City-Missouri River Navigation Company for the transportation of a general line of freight between St. Louis and Kansas City. By using this type of barge the insurance rates are sufficiently low so that first-class freight, such as pianos, silk goods, etc., can be carried at minimum rates. The hull of this barge is 156 feet long, 30 feet beam and 8 feet deep. It has a rather full modeled bow and a type of stern known on the Western rivers as a "basket" stern. The deck is flat throughout without crown or sheer. Four transverse bulkheads divide the hull into five watertight compartments. Between bulkheads Nos. 1 and 4, and for a width of 12 feet each side of the centerline, the main deck is dropped 5 feet to form an inner bottom, the inner bottom and main deck being connected by inner side plates, thus giving the barge a duble skin between bulkheads No. 1 and No. 4. The inner side plates and bulkheads Nos. 1 and 4 are carried up to a height of 10½ feet above the main deck to form the sides and ends of the cargo box. Bulkheads Nos.

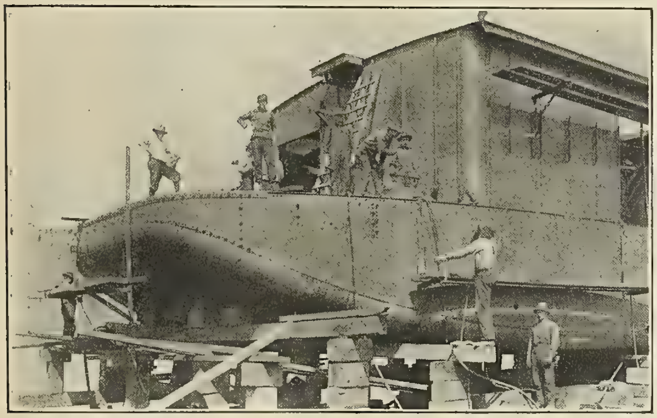


Fig. 6.—"Basket" Stern

Fig. 7.—Form of Bow

Fig. 8.—Barge Loaded With General Cargo

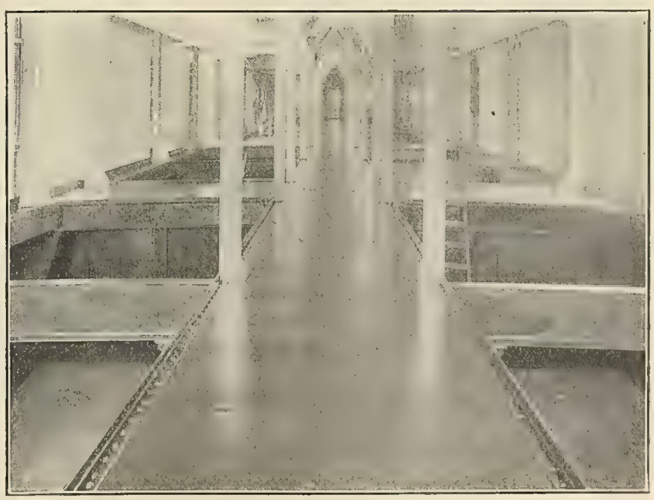


Fig. 9.—Interior of Steel Barge *Edgar Thomson*

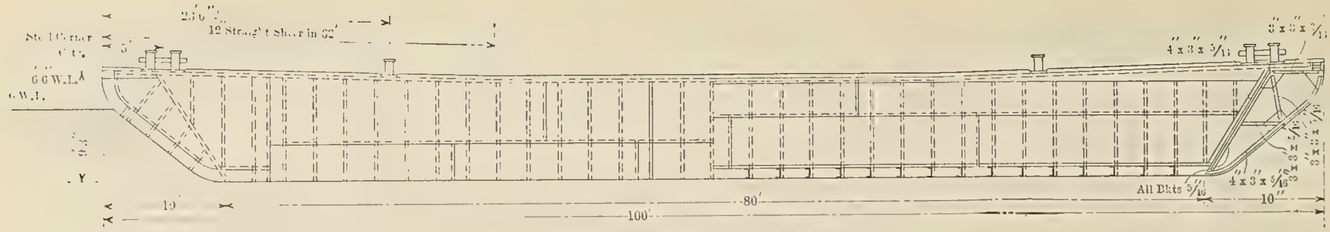
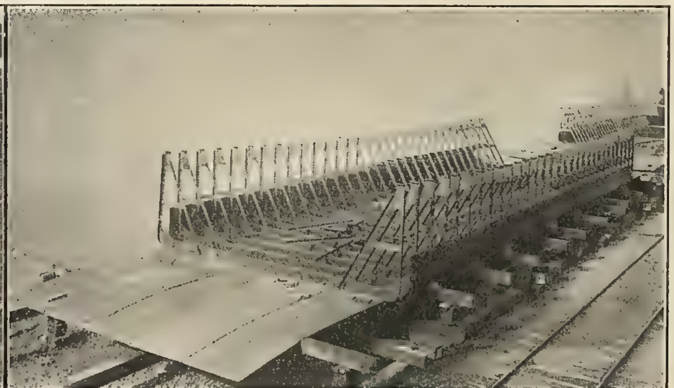
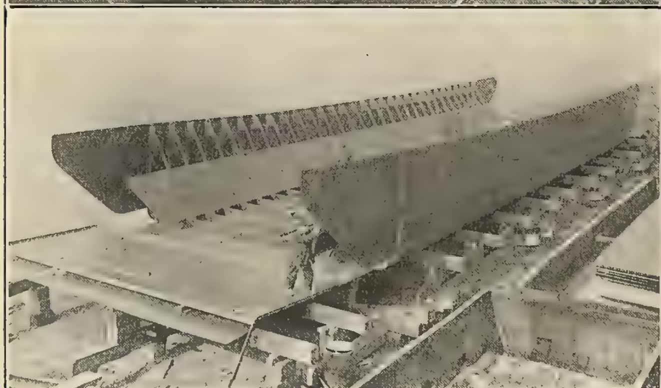


Fig. 10.—100-Foot Open Coal Barge

2 and 3 are also carried up to the upper deck to form fire partitions, being stiffened at the main deck by horizontal girders 3 feet wide.

A non-watertight keelson, 3 feet deep, runs between bulkheads Nos. 1 and 4. On top of this keelson, and spaced approximately 12 feet between centers, is a line of stanchions for the support of the upper deck. It will thus be seen that the cargo-carrying space in the barge is 24 feet wide, 15½ feet high and 120 feet long, divided into three compartments, the end compartments being 36 feet long and the center compart-





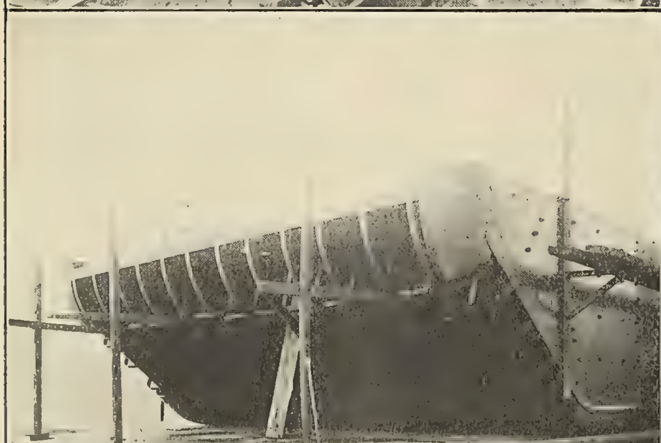


Fig. 11.—Floors and Bottom Plating

Fig. 12.—A-Shaped Framing

Fig. 13.—Side Plating

Fig. 14.—Inside Plating

Fig. 15.—End Connections

Fig. 16.—Interior of Finished Barge

ment 48 feet long. Access is had to each of these compartments by a rolling door 8 feet wide on each side of the barge, and by hatches in the upper deck on each side of the centerline, each hatch being 10 feet wide and extending nearly the full length of the compartment. Each end compartment also has a rolling door 6 feet wide leading to the forward and after decks, while rolling doors 6 feet wide in the upper parts of bulkheads Nos. 2 and 3 connect the end and center compartments.

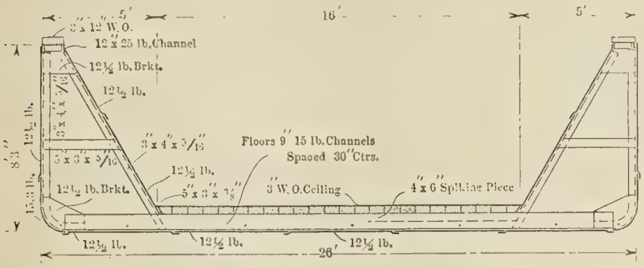


Fig. 17.—Midship Section of Coal Barge

In each corner of each cargo compartment a 4-inch drain pipe, with a gate valve, leads down from the inner bottom plating and outboard above the light load waterline to permit of easy cleaning at the end of the trip. Watertight manholes in the main deck give access to the end compartments of the hull and to the spaces between the inner and outer skins. A complete steam syphon system was installed, and to eliminate "sparring" 9-inch concrete-filled steel spuds


Fig. 18.—Decked Sand Barge

are placed in spud wells at both ends of the barge. This barge has two hand power capstans, together with a full complement of bitts, chocks, hand rails, etc. Before launching each compartment in turn was filled with water to a depth of 5 feet, and both the inner and outer skins made watertight.

This type of barge has a cargo-carrying capacity of 600 net tons on a draft of 6 feet. Fig. 8 shows the character of cargo ordinarily handled and the methods of stowing it in the barges.

Coal and Sand Barges

Another type of barge built by the American Bridge Company, which is used to a great extent on the Monongahela River and in the harbor at Pittsburg for the transportation of coal and steel billets, is shown in Fig. 10, while Figs. 11, 12, 13, 14, 15 and 16 show clearly the successive steps in assembling one of these barges at the barge yard.

The barge illustrated is 100 feet long, 26 feet wide and 8 feet 3 inches deep. The deck has a sheer of 12 inches, beginning at a point 32 feet from each end. A transverse watertight bulkhead is provided at each end of the barge, the bulkhead being sloped from the main deck at a point 5 feet from the end of the barge to a point at the bottom 10 feet from the end of the barge. The side frames between the bulkheads are A-shaped, the leg against the side plating being vertical, while the inner leg which takes the inner plating has a slope of 4 feet in the depth of the barge. The hopper bottom is of 3-inch white oak laid on 9-inch channel floors.

By referring to the half-inboard profile, Fig. 10, it will be noticed that a very strong head log is provided. This is an essential feature in barges for river use, due to the fact that all barges are pushed ahead of the towboat and not pulled. A very heavy steel casting is placed at each corner of the barge and securely fastened to the side, knuckle and rake plates, because when entering the locks the tow is seldom parallel to the lock walls, and the corner of the foremost barge is subjected to severe abrasion.


Fig. 19.—Oil River Barge

The cargo capacity of the open barge, illustrated, is 400 net tons on a draft of 6 feet 6 inches.

A decked sand barge, for use in connection with a suction dredge outfit, is shown in Fig. 18. Perhaps the most notable feature of this barge is the heavy side and deck construction. The sides of the barge are subjected to severe punishment on account of the method of handling. For instance, an empty barge is placed alongside the dredge, the lower or down-stream end being opposite the discharge pipe, and the barge is dropped down stream a little at a time as the cargo box is filled. The next barge to be filled is fastened at its forward end to the dredge, which lies up-stream from the barge being filled. The lower end of the second barge is held away from the dredge by the corner of the first barge. When the first barge is filled it is taken away, and the current swings the empty barge alongside the dredge in the correct position for loading. The heavy clam-shell buckets used in the unloading operation makes a very strong deck a necessity. At each loading the cargo box is filled completely, this quantity of sand weighing about 650 net tons, bringing the barge down to a draft of 7 feet.

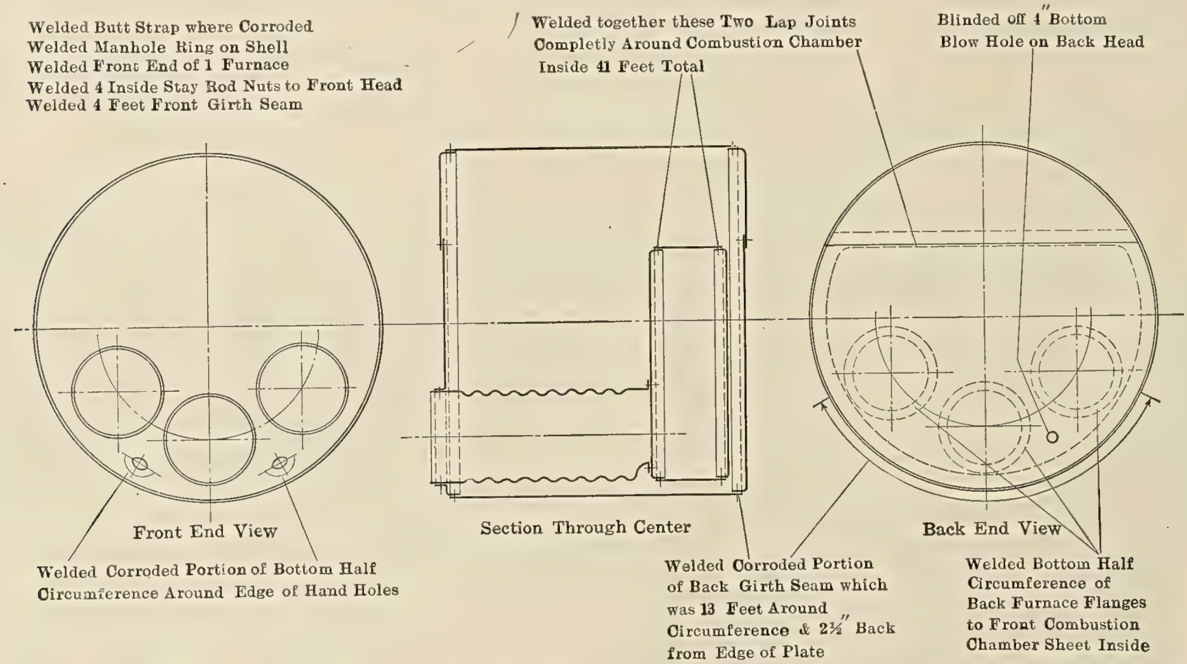
Oil River Barge

Fig. 19 shows one of three bulk oil river barges which were built recently from plans by and under the direction of Mr. George B. Drake, naval architect, New York City, for the Texas Company. In this barge there are three pairs of oil tanks having a combined capacity of 220,000 gallons. A complete system of in-take and discharge pipes is provided, the pump room being located in the after peak, together with all the valves. The steel deckhouse on this barge is equipped for the accommodation of a crew of four men.

Shipbuilding Returns.—The Bureau of Navigation reports 127 sailing, steam and unrigged vessels of 20,052 gross tons built in the United States during the month of May.

Repairs to Scotch Marine Boilers with Oxy=Acetylene Apparatus

Two boilers on the steamer *Meteor,* owned by the Pacific Coast Steamship Company, recently underwent repairs in Seattle, Wash. The work was done by the Olson-Klopf Welding & Cutting Company, Inc., with the Henderson-Willis oxy-acetylene process. On the port boiler 13 feet of calking edge was welded back on the head. One butt-strap was reinforced where corroded, one handhole and blow-off on the back head were reinforced, while in the combustion chamber 41 feet of calking edge, a patch, flame sheet, wrapper sheet and furnace end were welded. One manhole ring was welded and the front end of a furnace reinforced where wasted away. Three feet of girth seam were also welded. On the starboard boiler 12 feet of calking edge on the back head was welded, one butt-strap was welded and reinforced where corroded, one handhole and one blow-off in the back head were reinforced, 41 feet of calking edge was welded in the combustion chamber, and one manhole and 1 foot of shell on the front end of the boiler were welded. This is reported to be one of the largest repairs ever undertaken on boilers by the oxy-acetylene process.



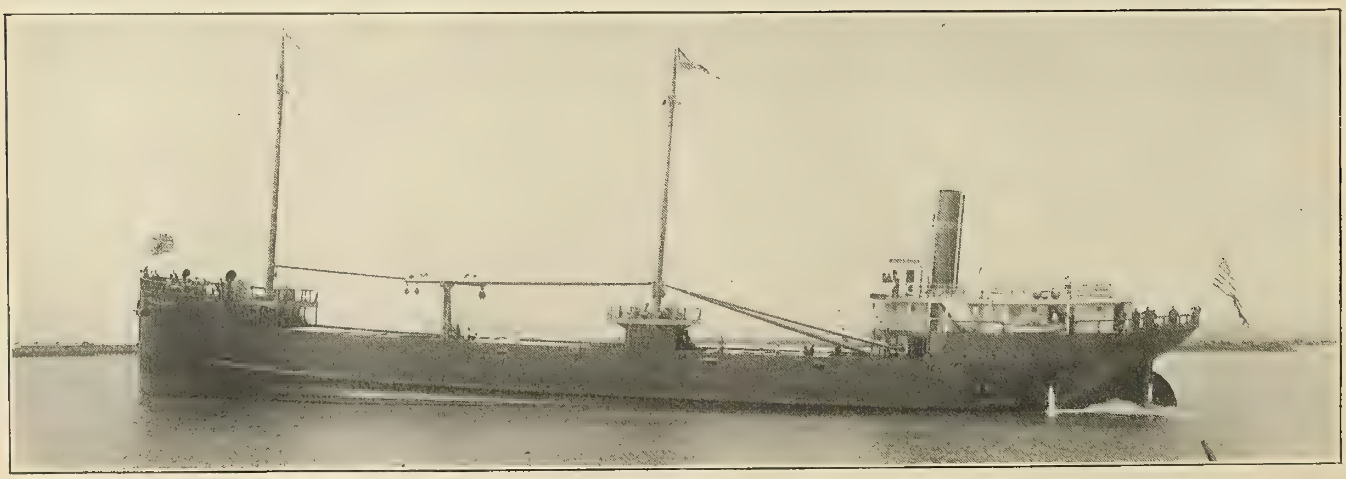
Welding Done with Oxy-Acetylene Apparatus on Two Scotch Boilers of the Steamship *Meteor*

Steamer Alvarado

The Craig Shipbuilding Company, Long Beach, Cal., has recently completed a lumber steamer called the *Alvarado* for the Long Beach Steamship Company. This vessel was built to carry lumber both in the hold and on deck, and certain of the holds are arranged to carry bulk oil. The following are the principal dimensions of the vessel:

Length overall	255 feet
Beam	42 feet
Depth, molded	16 feet
Gross tonnage	1,319
Net tonnage	940

Built to the Bureau Veritas rules for a single deck vessel, the *Alvarado* is also equipped to pass United States Steamboat inspection. She has a total lumber capacity of about 1,500,000 feet. Two steel masts, each fitted with cargo booms,



Twin-Screw, Single-Deck Steamer *Alvarado,* Designed to Carry 1,500,000 Feet of Lumber and a Cargo of Oil

the foremast with two booms and the mainmast with four booms, furnish ample means for handling the cargo. The cargo winches and windless are of the Craig Company's manufacture, while the capstan and steering gear are supplied by the Hyde Windless Company, Bath, Maine.

Propulsion is by twin screws driven by quadruple expansion engines with cylinders 11, 16, 23 and 34 inches diameter by 24 inches stroke. Steam is supplied by two Parker watertube boilers, in addition to which a donkey boiler is installed. Oil fuel is used under the Dahl system. The auxiliaries include an efficient electric lighting and oil pumping system.

The Loading and Steering of Lake Freighters

At the tenth annual meeting of the Pittsburg Steamship Company officials, masters and engineers, held in Cleveland, Ohio, March 23 to 25, Mr. F. B. Smith, chief engineer of the line, read the following interesting report on the loading and speed of ships:

During the past season a number of questions have come up relative to loading of ships, speed of ships under different conditions, and in connection with the speed the question of steering has been brought out quite prominently.

Taking up first the question of loading the ships, and the hogging in some cases and in other cases sagging of hulls, we have gone into this matter quite thoroughly. In observing the loading of several of the large steamers, we found that beginning at the after end of the cargo hold, putting a pocket in every other hatch, and we went forward to within about the sixth hatch, and then going back to about amidships and coming forward with another run in order to get the ship's bow down, this plan of loading had no bad effect whatever on one of our modern ships, and after this run had been continued through, on taking the draft forward, aft and amidships, the boat was practically on a straight line; that is, she drew as much water at both ends as she did amidships and showed no signs of material sag in the center. It has been proved in the loading that if the boat is sagged in the middle to any material extent while loading, it does not improve matters any to put extra heavy loads in both ends; that is, the sag in amidships still remains until the boat is unloaded.

But in a paper read by Naval Constructor Stuart Farrar Smith, at a meeting of the Society of Naval Architects and Marine Engineers, in New York, December 11 and 12, 1913, Mr. Smith stated: That in practical experience the middle of the length of a long vessel may move up or down as much as 6 inches with reference to the ends, depending on the conditions of loading, without any material injury to the ship, and that a temperature rise of 1 degree Fahrenheit may cause a rise in the middle of the ship of as much as ⅛ inch. Another paper was read by James E. Howard, engineer-physicist, covering a number of experiments of strains on ships' hulls, both at sea and while receiving cargo. In these experiments Mr. Howard used an instrument that would measure the stretching of both the deck and the side plates down to a point of 0.0001 inch, and by these tests he was enabled to establish accurately the vibrations caused by the revolutions of the engines separately from the vibrations caused by the weakness of the hull or by the sea.

It is a well-established fact that when the vibrations of the engine are synchronous with the vibrations of the hull, caused by the sea, the vibrations are greatly exaggerated and conditions may be materially improved by either changing the speed of the revolutions of the engine or by changing the propeller wheel. Also in Mr. Howard's experiments, he kept record of the changes in the form of the hull at different times in the day, according to the temperature, and found that the apparent draft of the ship, taking the marks forward and aft, was changed as much as 2 inches, and in the discussion on these papers, it was brought out that the builders or contractors of government ships frequently find in certain classes of vessels that they can increase the apparent deadweight of the ship by even blowing off one of the boilers, and this is done sometimes in order to increase the bonus on their contracts.

We have had the question up before now of boats being loaded to certain marks at the head of Lake Superior, and when they arrived at the Soo they were drawing more water forward than they were when they left their loading port without having come up a corresponding amount aft. This has generally occurred when they arrived at the Soo during very warm weather, and in talking this matter over with a number of men who have made practical experiments in such matters, they expressed themselves very freely to the effect that this difference was caused by the sun heating the decks and the upper part of the hull of the ship, and that a partial remedy for this would be to turn the hose on the decks and cool them down. It was stated that if we would take a transit and make observations along the sides of the hull of one of our long steamers, we would find the change in the shape of the ship would be very considerable in the effect of different ways of loading and in the different temperatures in which these observations were taken. I have in mind at the present time a case which happened in Cleveland a number of years ago when the tall electric lighting masts were being built. The foreman in charge of the erection of these masts was somewhat startled on a hot morning when he noticed that the mast was quite crooked, but as the day went by he noticed the shape was changing, and in the afternoon the bend was on the opposite side. I mention this to show how much one of our ships would be affected by the heat of the sun on the decks while the bottom of the hull is submerged in cold water.

In the tests we made on the last three boats, which were put in commission during the season of 1913, we noticed there was a very marked difference in the speed of the ships when good wheelsmen were at the wheel and when poor steering was being done. In one particular case, when Captain Watt was watching the steering in the pilot house and I was watching the wake aft and keeping track of the revolutions of the engine, steam pressure, etc., I noticed in one hour that the speed of the boat had dropped down nearly one-half mile, and also that the revolutions of the engine had been slowed up, but the steam pressure had been exactly the same; in fact, it had not varied as much as one pound during this period. I went forward to inquire how things were going there, and Captain Watt informed me that the wheelsman had lost control of her and did some very poor steering for a period of 35 minutes out of the hour. Another man was then put at the wheel and he did very good steering, so that the bad steering, lasting only 35 minutes, had slowed the boat's speed down nearly one-half mile during that hour.

In connection with this, I wish to mention the statement made by one of the naval officers at the meeting of the Society of Naval Architects and Marine Engineers, in which he spoke of a government ship with bilge keels for the purpose of experimenting as to how much bilge keels retarded the speed of the ship. The bilge keels were removed after having made a trial run. Then another run was made over the same course with the same trim of vessel, and under almost exactly the same conditions, and it was found that it took more engine power to drive the ship at the same speed without the bilge keels than she had made with the bilge keels, but they discovered the cause, which was poor steering. The difference in the power was quite considerable, and the naval officer said it was a well-established fact that con-

tractors in running government ships on their trial trips were very particular to get a good helmsman, as the difference in speed attained in that way made quite a big difference with the amount which they received for their contract.

The mate on this steamer made it a practice of remarking in the presence of the wheelsman that nobody could steer that boat and keep her close to her course. I noticed, however, that before we got across the lake, and, in fact, for the last half of the distance across Lake Huron, the steering of the boat had been very much improved and also the speed of the boat had increased. We found later, however, that there was too much lap on the controlling valve of the steering engine, and after that was corrected we were told that the boat steered better, and I saw no reason why she should not steer as well as either one of the new ships that came out last summer. Also, after those steamers were put in commission, we found there was a great difference in the speed of the three boats, but after making a run across Lake Huron on two of those ships, under almost exactly the same conditions of weather and trim, there was only a difference of three minutes in the time across Lake Huron, and only a difference of 135 revolutions. The weather was almost identically the same. There was only a difference of 0.4 of a revolution per minute in the two boats, and another very important point is that the boat that made the most revolutions in crossing the lake, and that had the highest revolutions per minute, was the one with the coarsest pitch of her wheel. Both of these boats on these runs were steered very fine, and by actual measurement on the chart made by Captain Watt there was only one-fourth mile difference in the distance they ran, so that this appears to be one of the best real comparisons we have had, and demonstrated pretty thoroughly that where the boats are well steered, make good courses, and have the same kind of weather, there is practically no difference in their speed.

Going into the question of propeller wheels, I think we have demonstrated pretty thoroughly, not only on the tests made last summer but in a great many tests that we had made prior to that time, that in designing a propeller wheel the first thing to determine is the speed, or the number of revolutions per minute, that we wish the engine to make, and from this we must determine the pitch of the wheel that will give the best results for a ship of the type under consideration; then the area of the wheel must be decided upon and the wheel should be made as near as possible to a true screw, at the pitch that has been determined, and there is found to be a loss if the wheel is shifted from that pitch, either making it coarser or finer. If it is found that a mistake has been made in the dimensions of the wheel, it would be more economical to design a new wheel than to endeavor to correct the mistake by making a worse one in changing the pitch.

When the vessel is pitching in a seaway, throwing the propeller out of the water, there is quite a difference in the way different engineers handle their engines. Some of them watch their throttling very closely, shutting off the throttle as the wheel comes out of the water, and the engine begins to speed up, and giving her full throttle again as soon as the wheel has become submerged, and in that way men who have given it special attention keep their engine running almost at a uniform speed; while with others I have noticed that they simply check their engine down in a seaway and do very little throttling, claiming that they make just about the same time. This has not been borne out in practice in any of the experiments that I have seen tried out. It has been my observation that those who watch the throttling very closely make better time in a head sea, and do it with considerably less strain on the engine as well as on the ship, and it occurs to me that this would be a very important matter for our older engineers to bring to the attention of the young men who are coming up in the business so fast; in fact, the handling of the engine is one of the things that I have noticed our young engineers are not as proficient in as the men who have been in the business for a long period of time.

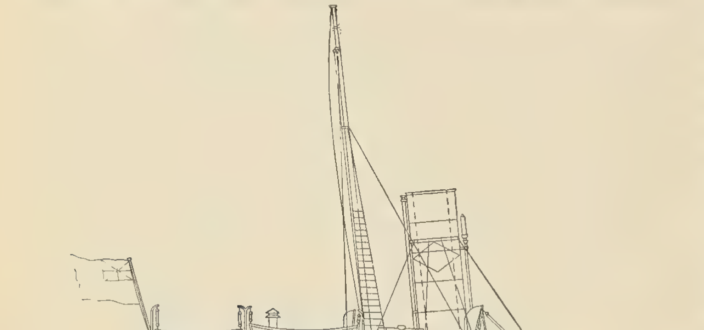
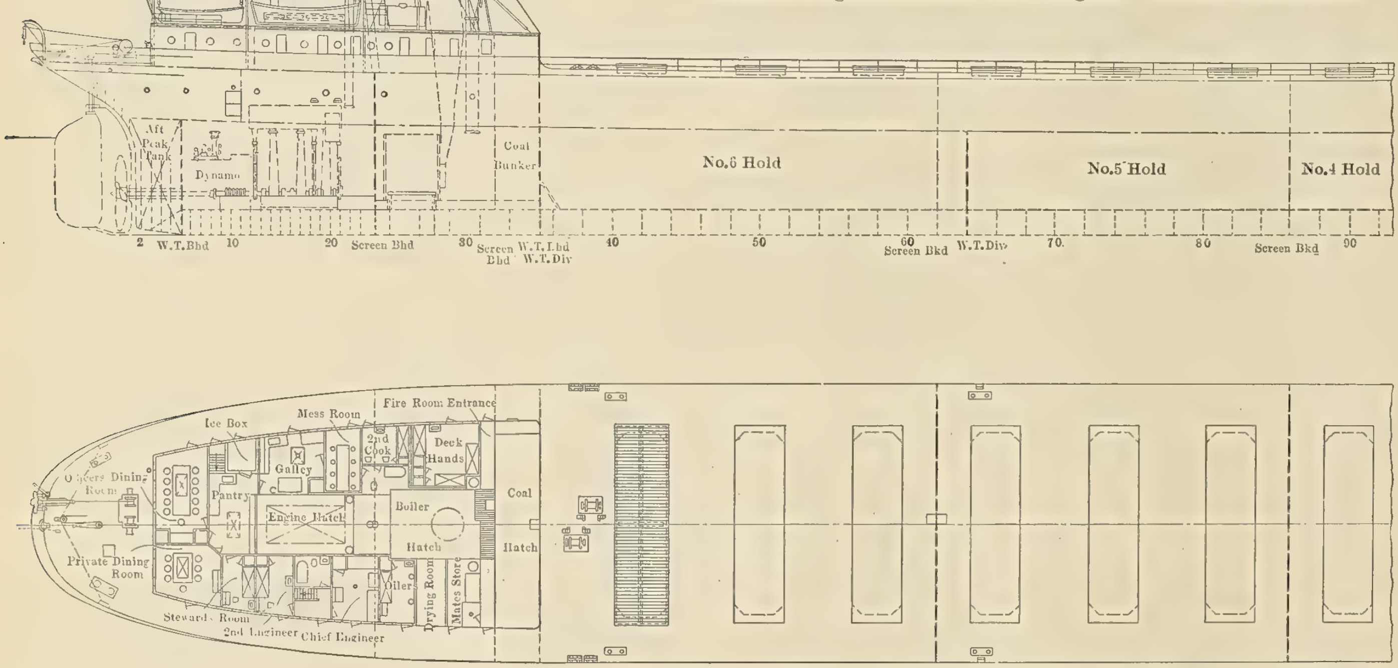



Fig. 1.—Profile and Deck Plan of 550-Foot Bulk Freight Steamer built

Danger of Handling Heavy Weights in Cold Weather with Chain Slings

A pulley 30 feet in diameter with a 4-foot width of face had been cast in two halves. The joints had been planed, and the pulley was ready to be put in the pit lathe to be bored and machined on the face. There was very little head room to spare, and it was necessary in handling the pulley to use a chain sling around its face, as this gave a shorter bight than the heavy rope slings, and just allowed sufficient hoist to permit the traveling head of the crane to carry its weight out over the center of the face plate of the lathe.

Each half of the pulley had four arms, and it was to be chucked on the face plate of the lathe, which was about 12 feet in diameter, by suspending it on blocks placed under the arms and secured by bolts and straps to the face plate. One-half of the pulley had been placed in approximately the center of the face plate of the lathe, and the machinist was standing on the hub adjusting and securing the blocks, when the chain snapped; the pulley fell, and its overhanging rim striking the edge of the face plate, broke off big pieces of it and the arms; the whole mass with the machinist was plunged down into the bottom of the pit a distance of 18 feet.

In falling the broken pieces of the rim struck large blocks that were close to the edge of the pit, and that had been used to chock the pulley when shifting the slings as it was being turned rim upwards, and these were carried down with the rest of the falling mass. The jar shook the building as though shaken by an earthquake, and all hands in the shop ran to the scene of the accident.

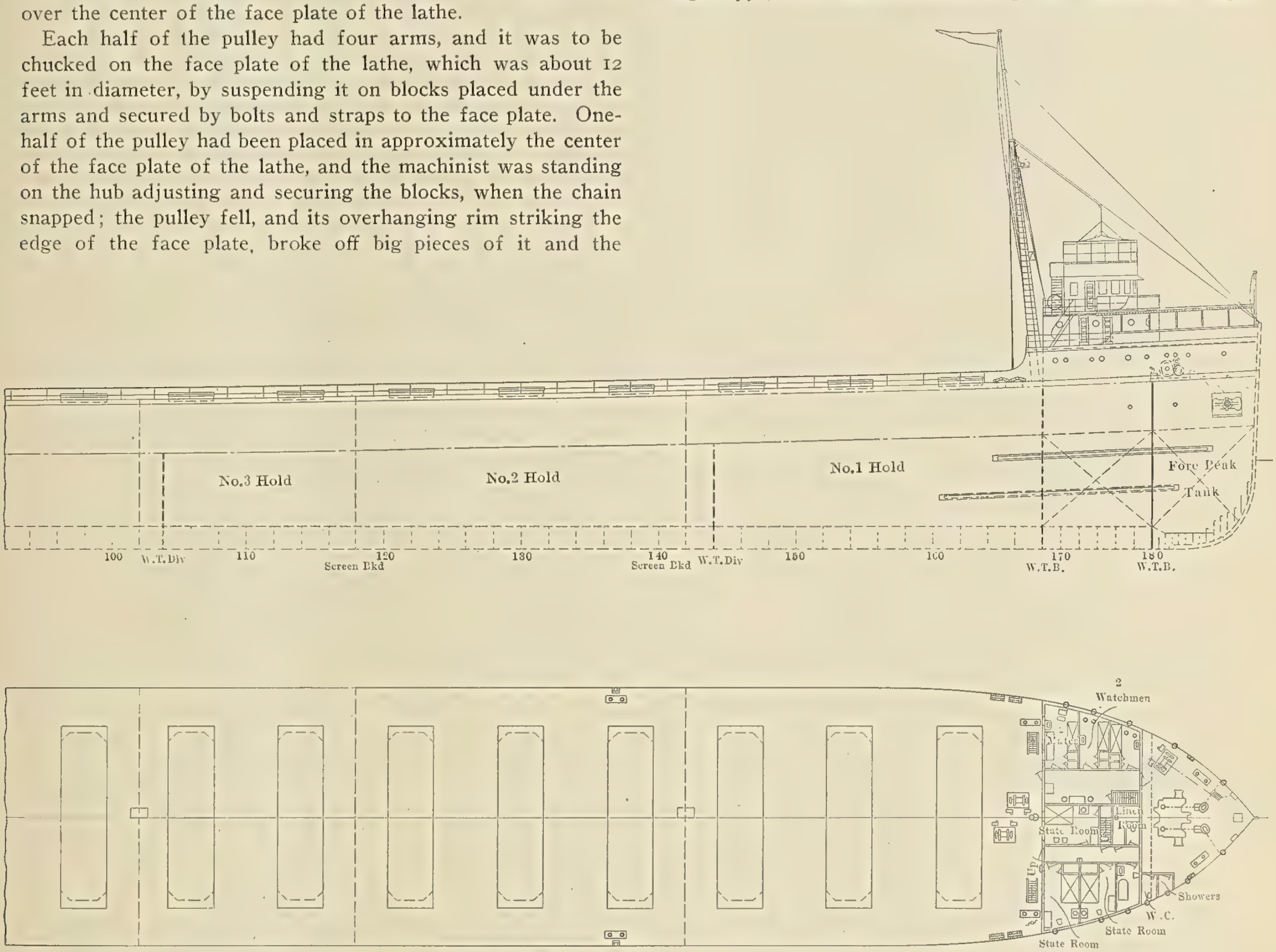
When the dust had cleared a little, a ladder was brought, and the machinist was taken from the pit, not crushed beyond recognition, as every one expected he would be, but with only a bad scalp wound, a bump on the forehead and a bad shaking up. The large blocks in falling in the pit had crossed in such a manner with the large, heavy pieces of the broken pulley as to keep them off the body of the machinist, a most miraculous escape.

The day was bitterly cold, and the doors of the shop being open while handling the pulley, the chain became crystallized and snapped under the strain. J. E. C.

Great Lakes Bulk Freight Steamer

The Collingwood Shipbuilding Company, Limited, Collingwood, Ontario, have in hand at present a steel bulk freight steamer for the St. Lawrence and Chicago Steam Navigation Company, Limited, Toronto. The principal dimensions are: Length over all 550 feet, beam molded 58 feet, depth molded 31 feet.

The vessel is being built in excess of the highest class in the Great Lakes Register, and is of the single-deck, bulk-freight type, with side ballast tanks 5 feet wide to the height



by the Collingwood Shipbuilding Company for Service on the Great Lakes

of the main deck stringer. The construction is on the arch and web frame system, the arches and webs being spaced 12 feet apart, with channel frames between spaced 3 feet apart. A double bottom 5 feet deep is fitted for water ballast, extending all fore and aft, subdivided by a center keelson and transverse floors into nine watertight compartments.

The cargo space is subdivided into six separate holds by five transverse screen bulkheads. There are sixteen hatches spaced 24 feet centers, 38 feet by 10 feet, with steel coamings 15 inches deep and wood hatch covers 4 inches thick, supported on steel strongbacks, with double tarpaulins on top, all being rigidly fastened down by Mulholland's patent hatch fasteners spaced 3 feet 4 inches apart. In addition to this the hatch covers are also held down by strong angle iron hatch battens, securely connected by forged eye pads to the deck plating.

The vessel has a top gallant forecastle with crew's quarters and passenger accommodations. There is a steel deckhouse on the focreastle deck, containing a stateroom, office and bathroom, for the captain, and a large observation room forward with access from captain's quarters, and a steel pilot

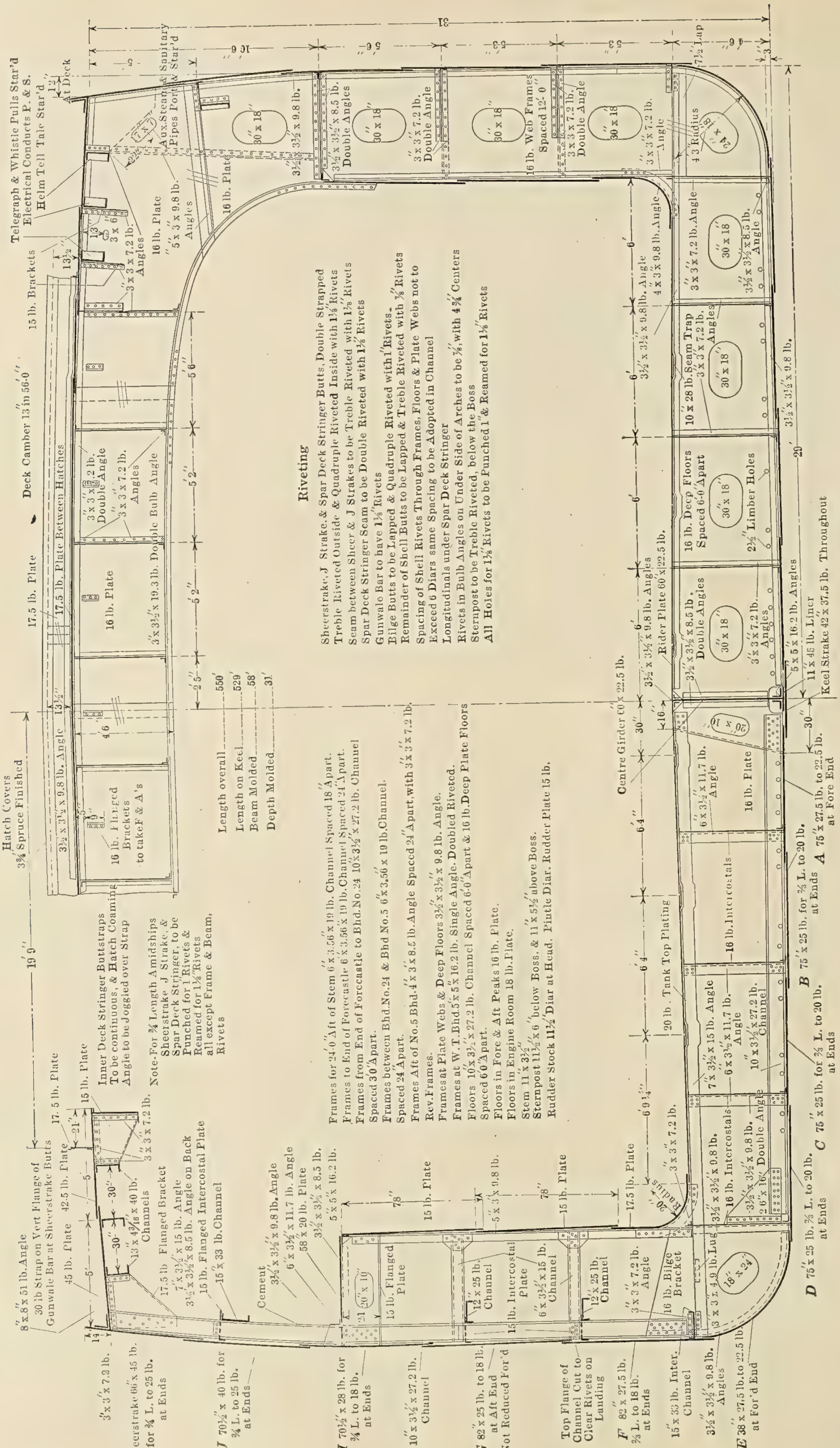


Fig. 2.—Midship Section of 550-Foot Great Lakes Bulk Freighter

house on top. A steel deckhouse at the after end of the spar deck contains accommodations for the crew. Here also is located the galley, refrigerator and pantry and dining rooms.

A steam steering engine is placed on the main deck aft, geared to a semi-circular quadrant, with a spring buffer arrangement to take care of excessive strains on the rudder. Connection to the pilot house stands is by a rack and pinion transmission gear. An emergency steam steering gear is also fitted to the same quadrant.

The vessel is driven by a vertical triple-expansion marine engine, having cylinders 24 inches, 40 inches and 66 inches diameter by 42-inch stroke, capable of developing 2,400 indicated horsepower, supplied with steam by three Scotch boilers 13 feet diameter by 11 feet long, with a working pressure of 185 pounds.

The vessel is equipped with Howden's patent system of forced draft.

The Manchester, a New Harbor Express

The harbor express designed and recently placed in operation by the Lehigh Valley Railroad's floating equipment department has been built for the rapid handling of freight in New York harbor. It gives a maximum of service at a minimum of cost, and is proving particularly useful for the disposal of small consignments. It does, in a measure, the work an express wagon does on shore. It has been appropriately named the *Manchester*, as Manchester, N. Y., is the location of the Lehigh Valley Railroad's new freight classification station, which is a model of efficiency and economy.

The *Manchester* is 120 feet long over all; 32 feet breadth, molded; 16 feet depth of hold. Propulsion is by a 22-inch by 26-inch high-pressure engine, supplied with steam by a three-furnace Scotch boiler, 13 feet in diameter by 12 feet long. The freight house is amply lighted, an Engberg dynamo, 4½ kilowatts, supplying the power. A cluster of lights that can be carried from the boat into the car where freight is being transferred has also been provided.

There are a number of interesting details in the design and construction of the *Manchester*. There is no "drag" as in the case of boats which trim by the stern, where the incline to the deck adds to the cost of handling freight. With 70 tons of coal and 40 tons of water the *Manchester* will have a freeboard at the forward gangway of 7 feet 4 inches and at the after gangway of not less than 7 feet. This will make loading at the after gangway practically as easy as at the forward gangway. In designing a boat with as much freeboard as the *Manchester* has it was necessary to get the weights as far down in the ship as possible. After the contract was placed it was decided to build a tank in the forward compartment instead of building the round tanks as shown, or, in other words, to give the boat a double bottom. This was successfully done.

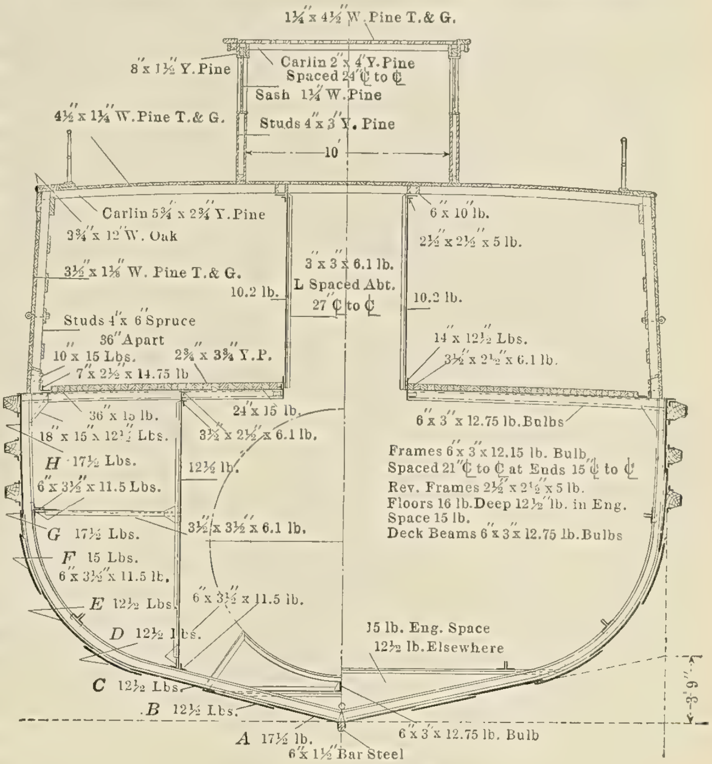


Fig. 2.—Midship Section

The location of the hoisting engine is on the upper deck, in order to give as much clear deck space as possible. The amount of hoisting is also greatly reduced, as most of the freight is handled on trucks without the assistance of the hoisting. The height of the main deck is responsible for this saving, which will probably amount to about one-eighth of 1 percent a ton.

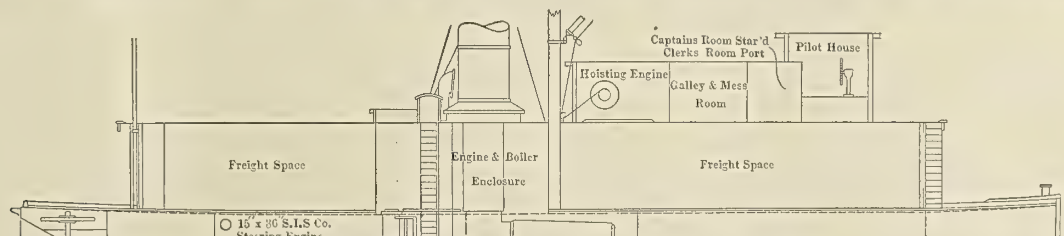


Fig. 1.—Longitudinal Section and Half Plan of the *Manchester*

Fig. 1.—General View of the Bush Terminal, South Brooklyn, N. Y.

New Bush Terminal Pier

At the Bush terminals in South Brooklyn, N. Y., a new two-story pier, 1,400 feet long and 150 feet wide, has recently been completed and leased to the American-Hawaiian Steamship Company. The Bush Terminal comprises seven piers, of which the new double-deck pier is No. 6. These piers are among the largest in the world, each being 1,400 feet long by 150 feet wide, the combined floor space of all the piers exceeding 2,000,000 square feet. The construction of the new pier was carried out under the direction of the Bush Terminal Company, and was completed in remarkably short time. The work began on July 23, 1913, and as the American-Hawaiian Steamship Company is to operate its fleet of twenty-eight

Fig. 2.—A Daily Waterfront Scene at the Bush Terminal

Fig. 3.—Side View of the New Double-Deck Bush Pier

Fig. 4.—Lower Floor of the Pier, Showing Railroad Tracks in the Shed

vessels through the Panama Canal, every effort was made to complete the new terminal before the Panama Canal was opened for traffic. As a matter of fact, the pier was completed almost three months before the canal will be officially opened.

The handling of cargoes at the Bush piers is carried out along strictly modern lines. The width of the pier sheds relieves all congestion, and trains from all of the ten trunk lines terminating in New York City run alongside the piers, making possible the transfer of cargoes from the holds of the steamships directly into the cars and *vice versa* without the necessity of using lighters or other cartage. A space of 270 feet separates the piers from each other, and it is possible for ships to load and unload on either side of these slips, leaving sufficient leeway for the unobstructed passage of smaller craft used in handling the freight.

Pier 6 is modern in every aspect. The foundation piles were driven 30 feet below the low water mark, capped with concrete, floored with steel and cement, on top of which is a paving of chemically treated asphalt block. The supporting columns are of steel and the girders of the same material. The upper floor is of 4-inch lumber, covered with five layers of the heaviest tar paper, with an inch of yellow pine and another inch of maple on top. Melted tar is worked into the seams to make the floor absolutely air and watertight.

A double-track railroad runs along the entire length of the main deck. This is connected with the Bush Terminal Railroad, which in turn connects with all the big trunk lines. Electric and steam locomotives draw long lines of freight cars to and from the pier.

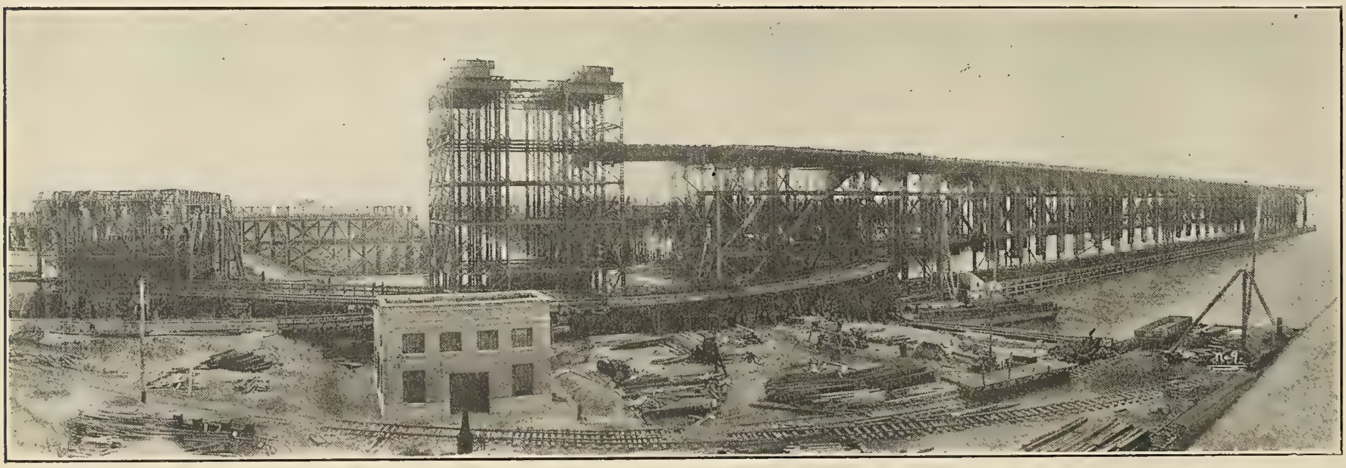
A 70-foot slip is cut in the head of the pier to permit lighters to berth without interfering with the big liners at the sides. The slips are dredged to a depth of 40 feet or more. Thus everything has been done to facilitate the movement of freight carried by water. Nearly 200 warehouses are backed up against the bulkheads, so that cargoes to be held in storage can be so disposed of without costly and damaging cartage, one of the biggest drawbacks to the use of many other pier locations in New York City and elsewhere.

Opening of the Cape Cod Canal.—The Cape Cod Canal, which extends from Buzzard's Bay to Cape Cod Bay, a distance of 8 miles, was formally opened July 29. The minimum depth of the canal is 25 feet and the width at the bottom 100 feet, while the approaches at each end of the canal, which have a depth of 30 feet, and which bring the total length of the new dredged waterway up to 13 miles, are from 250 to 300 feet wide at the bottom. The distance from New York to Boston via the Long Island Sound and the Cape Cod Canal is 260 miles, or about 70 miles less than the shortest route outside of Cape Cod.

The Chesapeake and Ohio Railway Company's New Coaling Pier at Newport News

The new steel coal pier of the Chesapeake and Ohio Railway Company, recently completed at Newport News, Va., promises to exceed the world's present record for the rapid transfer of coal from the railway car to the holds of vessels. The plant has a maximum dumping capacity of about 5,000 tons per hour, which equals the capacity of any other coal pier on the Atlantic seaboard.

With one exception all other coal piers on the Atlantic seaboard are of the power incline type, in which road or transfer cars are pushed up an inclined plane to the top of the pier and dumped directly into bins at a maximum rate of forty cars per hour. The New Chesapeake and Ohio coal pier differs from this type of pier in having special transfer cars of 110 tons capacity, into which are dumped the roadway



New Chesapeake and Ohio Coaling Pier at Newport News, Va. Dumping Capacity over 5,000 Tons per Hour

cars; the transfer cars are then raised to the top deck of the pier by double elevators.

It was estimated that the dumper and elevators could be handled at the rate of thirty cars per hour for each dumper and elevator, but this speed has been considerably increased in practice, and the indications are that this rate can be increased to forty cars per hour for each dumper and elevator, thus materially increasing the capacity over original estimates. This combination of mechanical car dumper and gravity pier has been used for some time at the Virginian Railway dock at Sewall's Point, but the arrangement of elevators for raising the dock or transfer cars to the upper deck of the pier has never, with one exception, been used in this territory.

The Chesapeake and Ohio Railway Company handles all the coal delivered to vessels in the Newport News harbor. This coal is received from a large number of mines located on the company's lines in the New River and Kanawha coal fields of West Virginia and Kentucky, and is delivered to all classes of vessels, from the tug boat, requiring less than 50 tons, up to the largest government colliers of 10,000 tons or more tons cargo.

This coal is first classified in the main yards and then the cars are sent to the dumpers and elevators at the end of the pier, where the coal is dumped into electrically propelled dock or transfer cars, which move under their own power over a level track, passing from the dumper over the scales, to the elevators, which raise them to the upper deck of the pier. The cars then move again under their own power over a level grade on the top deck to the desired bin and after dumping their load they move to the outer end of the pier, passing through a switch or turnout onto a central track, and descend under air brakes and under control of an overhead trolley down a 6¼ percent incline to the level of the surface tracks,

passing through the dumpers, and then, by means of switches, they pass to a position under the dumper to receive a new load. A sufficient number of transfer cars are provided to provide for thirty operations of each dumper and elevator per hour.

The coal dumped into the pier pockets is held by gates until it is desired to chute it into boats anchored along either side of the pier. The top of the pier is 90 feet above high water, making it possible to handle coal at any height from 5 to 47 feet above high water. The slip on each side of the dock is 1,200 feet long and 225 feet wide, allowing four of the largest boats to be loaded at one time. The slips at the outer end of the pier have a natural depth of 50 feet of water and at the inshore end of the pier the berths are dredged for a depth of 34 feet of water, thereby insuring the easy handling of the largest vessels with their cargoes.

The Hulett dumper and elevator, built by Wellman-Seaver-Morgan Company, of Cleveland, is a double machine, each side having an estimated capacity of inverting thirty road cars per hour (this capacity, however, has been exceeded). The arrangement of the elevators, scales, dumpers and tracks being symmetrical on either side of the center line of the pier, gives a track on each side of the dumper on which the transfer car receives its load and a central return track for transfer cars returning from the top of the pier; properly located switches allow the empty transfer car to pass into the track alongside of either dumper for another load. The two elevators, having a lift of 75 feet (to the top deck of the pier, which is ninety feet above high water), are operated in steel towers about 105 feet high. The elevators are counterweighted to equalize the pull on the machinery for the up and down movements of the platform and are electrically operated.

Electric power is used throughout in the operation of the pier. Each of the transfer cars has a load capacity of 220,000 pounds of coal. A sufficient number of transfer cars are supplied to provide for the operation of the dumpers and elevators to their full capacity.

The new pier has a larger number of spouts than any of the gravity or simple mechanical piers located on Hampton Roads. It is 22.3 feet higher than the Virginian pier and has as great a height as any pier on the Atlantic seaboard. The self-propelled cars are similar to those used on the Virginian docks, but of much greater capacity than any now in use, with one exception.

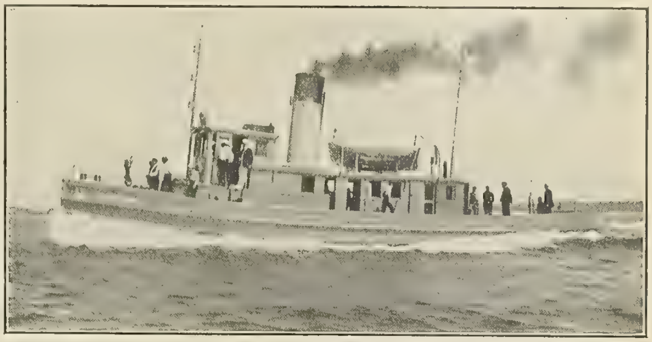
By the addition of this new mechanical gravity coal handling plant, the total rated capacity of the Chesapeake and Ohio terminal at Newport News is increased from 34,000 tons per day to 94,000 tons per day. The great advantage of this new pier to Newport News harbor will be the elimination of the loss of unnecessary time in loading vessels. While the rating of 100 tons per minute for this pier is unusually high, it has been demonstrated that the new pier is capable of developing this capacity.

Twin Screw Oil-Burning Tug Joseph Seep

The Greenport Basin & Construction Company, Greenport, N. Y., delivered to the Penn Mex Fuel Company, of Pittsburgh, Pa., on June 24, the twin-screw oil-burning tug *Joseph Seep* for service at Tuxpam, Mexico. The tug is 75 feet long overall, 18 feet 8 inches beam, with a depth of 7 feet, and a mean loaded draft of 4 feet 3 inches. The framing of the tug is of white oak, the planking of yellow pine and the decking of Oregon pine, while the hull is coppered for use in Mexican waters.

The contract for the construction of this tug stipulated that the vessel should be delivered within one hundred working days after the contract was signed. As a matter of fact, the tug was completed in eighty-seven working days, and will be delivered to the owners two weeks ahead of contract time.

Propulsion is by two 150-indicated horsepower inverted compound engines with cylinders 8 and 18 inches diameter by 12 inches stroke, supplied by the Portland Company, Portland, Me. The shafting is of steel, composition covered out-



Oil-Burning Tug Built in Record Time for Mexican Service

board, while the propellers are of composition. Steam is supplied by one Almy watertube boiler fitted to burn oil fuel on a combined Coen and National Transit Company system, with certain improvements as found desirable by the builders. Two cylindrical iron fuel oil tanks of 1,700 gallons capacity are installed alongside the boiler, while the water is carried in cylindrical iron tanks having a capacity of 1,300 gallons. The engines have an independent condenser, while the pumps are of the Blake and Kingsford Foundry & Machine Company makes. The system of communication between the pilot house and engine room was installed by Charles Cory & Son, and the electric light outfit was furnished by the Casey-Naser Electric Company, of New York. Thomas Drein & Son Company, Wilmington, Del., supplied the life-saving apparatus.

This tug was turned over to the owners complete ready for use and will proceed to her destination, Tuxpam, Mexico, by way of Galveston, in charge of Captain James H. Pierce, master, and Clarence J. Pierce, chief engineer. The speed of the tug on trial was 11.08 knots.

New Excursion Steamer Mandalay

An unusually interesting vessel has been placed in service this season on the Hudson River. She is known as the *Mandalay* and was designed by Messrs. J. W. Millard and Bro., naval architects, New York, for the Delaware and Hudson Steamship Company, New York. The hull of the boat is the hull of the former railway transfer steamer *Express*, the upper works of which were destroyed recently by fire. By slightly remodeling the form of the bow the hull has been rebuilt into a first class modern excursion steamer, typical of the luxurious river and harbor steamers which have been designed by Messrs. J. W. Millard & Bro.

The construction of the steamer was carried out by the Morse Dry Dock & Repair Company, Brooklyn, N. Y. In addition to the remodeling of the bow, the entire superstructure, including three joiner decks above the main deck, is entirely new construction. The main engines, condensers, thrust bearings, propellers, boilers, pumps, dynamos, steering engine and other auxiliaries were taken out of the hull of the *Express* and, with the exception of the main engines,

condensers, shafting, thrust bearings, donkey pumps and sea valves, a complete new outfit of machinery and boilers was installed.

The principal dimensions of the *Mandalay* are:

Length overall	283 feet
Length between perpendiculars	272 "
Breadth, molded	44 "
Breadth, over guards	61 "
Depth, molded	14½ "
Draft	9½ "
Gross tonnage	1,120
Net tonnage	407
Indicated horsepower	2,500
Speed, miles per hour	18
Number of passengers	3,000

and for supports to the windlass, capstan, chocks, cleats, etc. The whole main deck is laid with 3¼-inch Oregon pine. The engine and boiler rooms are encased by steel plating and a railing is fitted on the main deck around the cylinders of the main engines, which extend about 5½ feet above the deck.

Longitudinal stiffness and general rigidity have been obtained by steel bulwarks and houses on the main deck, together with steel stanchions, which have been fitted between the decks throughout. On the saloon deck is a large dancing floor and in way of this space a special trussing arrangement is provided in the form of longitudinal beams or trusses. This arrangement was adopted in order to eliminate so far as possible all obstructions to dancing. In this way only two stanchions are required on the dance floor proper.

The observation deck is in the form of a trunk deck with the sides stepped down for the storage of lifeboats, thus forming a separate boat deck and allowing an unobstructed view in all directions from the observation deck.

Fig. 1.—Twin-Screw, Open-Deck Excursion Steamer *Mandalay*. Capacity, 3,000 Passengers; Speed, 18 Miles per Hour

The Hull

The form of the hull is very fine, conducive to good speed and yet the boat has proved remarkably stable on her trial and subsequent trips.

A bar keel, 8 inches by 2¼ inches, runs the full length of the hull. The frames are 4 inches by 3 inches by 7/16-inch angle bars, spaced 24 inches apart. Reverse frames, 3 inches by 3 inches by 5/16 inch, are fitted to each frame, while heavy web frames are spaced every 10 feet. Ordinary floors, 7/16-inch thick and 22 inches deep, are fitted in the bottom, while under the engines and boilers the thickness of the floors is increased. The side and bottom plating is 7/16-inch thick, while the sheer and garboard strakes are ½-inch thick.

Five watertight bulkheads divide the hold into six compartments. The bulkhead at the after end of the engine room has a watertight door for access to the propeller shafts. The main deck beams, which have a crown of 10 inches in 60 inches, are bulb angles 8 inches by 3½ inches by 7/16 inch connected to the frames with ordinary beam knees.

The hold forward of the boiler room is fitted with a tongued and grooved wood deck throughout the accommodations for the crew. Strips of plating are fitted to the main deck beams to take the coamings of the steel house

General Arrangement

Arrangements for the convenience of passengers and crew have been well taken care of. The galley and crew's quarters are on the lower deck, together with the officers' mess. These are very roomy and the galley is fully equipped with all necessary appliances.

An elaborate bar room and large toilet rooms for men, officers and crew are provided on the forward part of the main deck. The after part of this deck is taken up largely with the lunch room and its accessories. The usual dining room has been dispensed with and a buffet lunch counter installed.

Directly above this on the saloon deck is the dance floor, which is covered with ⅜-inch linoleum and provided at the forward end with a slightly raised platform for the orchestra. Over the platform a sound well, or trunk, is provided so that the music can be heard by those on the deck above. Just forward of the dance floor is the hospital, retiring room and large toilet rooms for women.

The main saloon at the forward end of the saloon deck is artistically decorated in white with gilt trimmings. In this room is installed a very complete soda fountain, which bears the distinction of being the largest soda fountain ever installed on board ship. The floor of the main saloon is laid with "Dreadnought" tiling, making it not only substantial, but attractive and easy to clean. Large, roomy seats are built in along the sides of the saloon.

As the *Mandalay* is designed for a large excursion boat, her decks are unusually spacious and, for the most part, are entirely open. In order, however, to cut off any strong wind, wind shields have been provided where necessary. These are in the form of large sliding doors of mahogany with plate glass panels.

A very cosy and elaborately decorated observation room is provided forward on the observation deck. At the after end of this room a candy stand has been built in.

At the forward end of the hurricane deck is a large pilot house, containing all the necessary control appliances for steering and maneuvering the ship. A flying bridge extends athwartships on a level with the floor of the pilot house, while at the after end of the same deck are two smaller flying bridges, one on the port and the other on the starboard side, which enable the officers to maneuver the vessel with precision when docking.

Three searchlights are provided; one is a 30-inch projector on the pilot house, while the other two are 18-inch projectors located one on each of the after flying bridges. Aft of

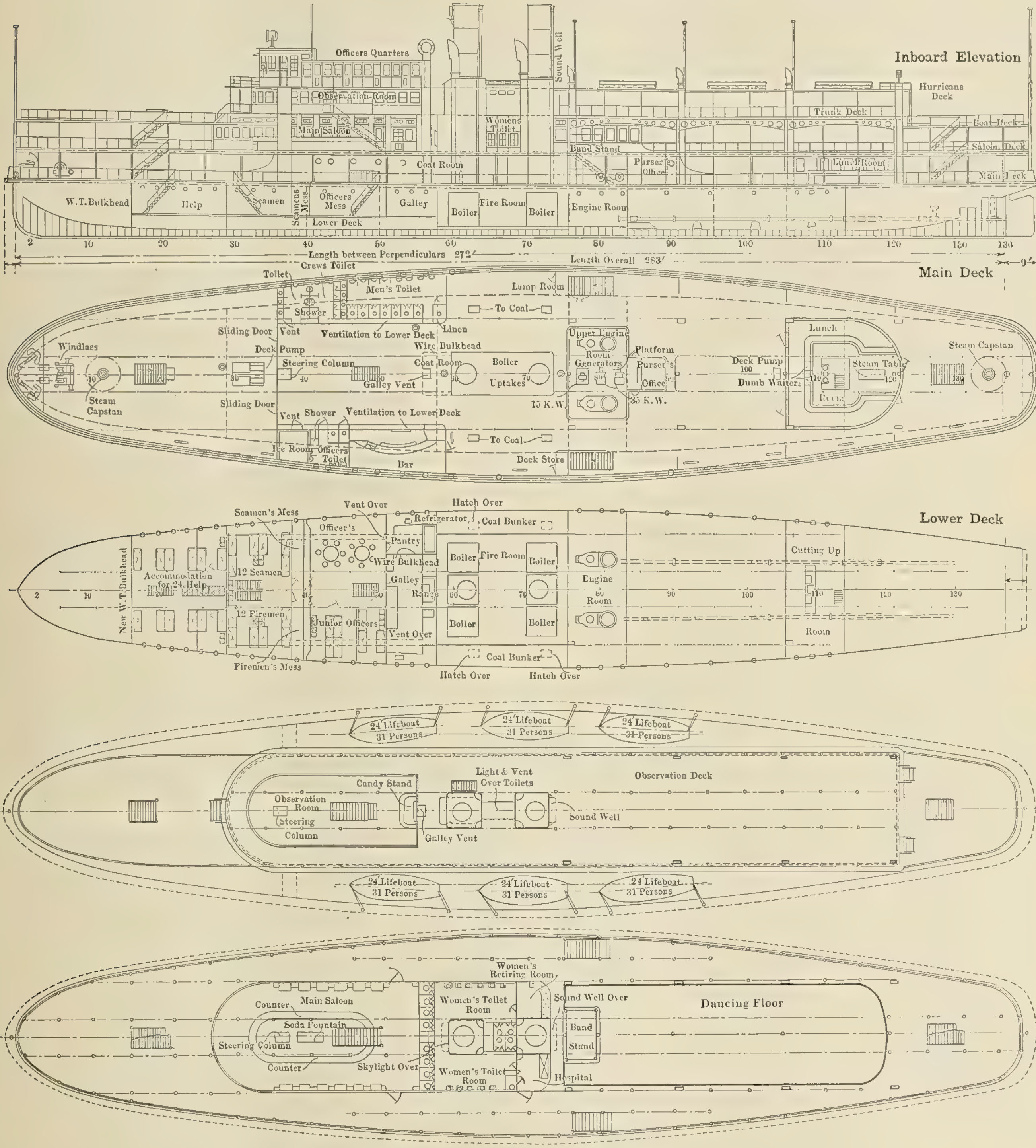


Fig. 2.—Inboard Profile and Deck Plans of the *Mandalay*

the pilot house on the hurricane deck are accommodations for the captain, chief engineer and officers. These accommodations are remarkably complete in every detail.

"Nevasplit" panels have been used for deck paneling in the restaurants, saloon and hurricane decks, making the paneling not only decorative, but very strong and durable. A very good effect has been obtained by marking off the wainscoting in the main restaurant to represent large white tiles set with black cement, the wainscoting throughout and the flooring in all but the main saloon and observation room being of "Asbestolith," making them practically fireproof. The flooring in the main saloon and the observation room is done in "Dreadnought" tiling.

Machinery

The main engines, which were in the original hull, and which were built by the Harlan & Hollingsworth Corporation, Wilmington, Del., have been thoroughly overhauled under the direct supervision of Mr. E. P. Morse, Jr., at the Morse Dry Dock & Repair Company's plant. The engines are compound condensing with cylinders 26 and 48 inches in diameter and 36 inches stroke, developing altogether 2,500 indicated horsepower when running at 100 revolutions per minute. The condensers, which are of the surface type, with about 4,000 square feet of cooling surface, are built into the engine framing and act as columns supporting the cylinders.

Steam is supplied by six Almy watertube boilers arranged in two batteries of three boilers each, so that they can be fired from the same platform, which is between them. The boilers are fed by two 9-inch by 6-inch by 10-inch Blake Admiralty feed pumps. The pumps are arranged so each battery may be fed independently or together. This same arrangement is also carried out in heating the feed water by the installation of a Reilly feed water heater with a set of twin coils. The coal bunkers are arranged amidships at each side of the boiler room and have a total capacity of 120 tons of coal, which is sufficient for about a week's supply.

Auxiliaries

The auxiliary pumps for the fire, sanitary and drinking water systems were supplied by the International Supply Company. The pumps are arranged so that all can be connected to the fire system.

Electric current is supplied during the day by a 15-kilowatt generator directly connected to a vertical reciprocating engine, while at night two 35-kilowatt Curtis turbine generators are placed in service. The entire electric installation throughout the ship was furnished by the General Electric Company, Schenectady, N. Y. About 1,000 lights are installed, together with the three searchlights mentioned above.

The vessel is steered by a hand and steam steering gear of the Williamson type. There are also Williamson steam capstans and windlasses. The lifesaving appliances include six lifeboats and six liferafts, all of which can be handled easily by six sets of davits. The davits are of solid steel forgings made at the Morse Dry Dock & Repair Company's shops.

Care of the Electric Plant on Board Ship

The Principal Faults to be Found in Wiring—Points on Buying, Laying and Inspecting Cables, Wires, Etc.

BY SIDNEY F. WALKER

Cables and connecting wires of any electric light or power plant, or any other installation using electricity, form the weak portion of the plant. In the first place, the old caution should be given: do not cut the cost of the cables. Of course, you are to get the very best value for the money that is spent; but assuming you get good value, the money spent in the insulation and protection of cables, and of connecting wires generally, will repay itself over and over again. Put it in another way. Five percent or 10 percent saved in the cost of cables, providing that good value is obtained with the larger sums spent, may lead easily to the expenditure of ten or twenty times the amount saved, besides the great inconvenience involved.

Cables and connecting wires are subject to two principal faults. The smaller ones on board ship are subject to being parted, to the conductor being severed, and the supply of current to the apparatus to which the wire is leading being cut off. The larger cables, even very large cables, are occasionally subject to the same trouble; but cases of this kind would necessarily be rare.

Both large cables and connecting wires of all kinds, down to the very smallest flexible cord, are liable to short circuits, whole or partial, due to defective insulation. The insulation may become defective through the insulating material in the first instance being inferior, through the cables being carelessly laid, or through accidents, such as are common to every apparatus that is fixed on board ship. When even the strongest built ship is "working" in a heavy seaway every part of her is "working" more or less, is more or less in motion, and the results of the working and the motion may lead to the insulation of the cables or connecting wires being damaged.

In laying cables great care should be taken that where they have to make elbows to go round curves, say when going through the watertight subdivisions, provision is made for the expansions and contractions that go on with the changes in temperature, which seamen know only too well, and for the strains due to the changes of position when the ship is working heavily in a seaway. Provision should also be made to withstand the vibration to which the whole ship is subject when driven by reciprocating engines. Everyone on board becomes used to it; the old craft herself becomes used to it. Notwithstanding all that the vibration does its work, and the great danger is that one or the other of these causes, sometimes working separately, sometimes working together, may damage the insulation. The insulating covering of all cables and connecting wires is mechanically weak. All electrical insulating materials are mechanically weak. That is one of the great difficulties the electrical engineer has to contend with. He must provide insulation under all sorts of conditions where mechanical strength is also of the utmost importance, and he has the greatest difficulty in doing so.

There is the usual difference of opinion among electrical engineers as to whether armored cables should be employed on board ship or not. Armoring has the advantage that it will resist some of the strains that have been referred to if the armor has been properly put on. On the other hand, the armor sometimes passes on a squeeze. Modern cables are very much better constructed than those of twenty years ago; but there is still the possibility that in the process of laying on the armor, when the cable is passing through the armoring machine, a certain amount of squeeze may be given to the insulating envelope at a certain weak point. The

squeeze will not be found out until a long time afterwards; but it is like a man having a weak chest, or a weak organ of any kind, when the strains come on it finds out the weak spot.

A caution should be given here in buying cables if india rubber is used as the insulating envelope. The writer believes that it is not so common now to employ inferior African rubber as it was some ten or fifteen years ago. African rubber, as put upon the market to-day, is better than similar rubber that was on the market before the great development of rubber planting. As late as ten years ago African rubber was worth only one-fifth as much as Para, Brazilian rubber, and when made up into the insulating envelope of a cable there was no test that would discover the difference. The test came, however, not very long after. Where a cable made with a proper portion of Para rubber would last, say, ten years, those made with African rubber would often not last one year.

There is the usual controversy also as to whether rubber, bitumen or paper is best for the insulation of cables for use on board ship. At present the writer prefers rubber, good rubber, with 30 percent of Para; the insulating envelope being so made up by vulcanizing, and by properly preparing the different layers, that the final product is a continuous tube, closely encircling the conductor. And he likes the rubber-insulated conductor, after it has been protected with some form of jute wrappings, impregnated with waterproof material, drawn into a flexible lead tube of fair thickness. The lead tube, in his opinion, protects the insulation better than armor, and it is not so liable to pass on any squeeze that comes. It protects the insulating envelope by accepting the squeeze in its own body.

Bitumen has been largely used for board ship work; but it has the objection that in hot climates it naturally tends to soften, and it is liable to cracks with the working of the ship, with changes of temperature, etc.; while if cracks develop the salts from the sea will find their way through the crack to the conductor, and in the case of small conductors will part them.

The old rule that has been given for other apparatus may be repeated in connection with cables. Examine every inch of the cable and of all connecting wires as often as you possibly can. In particular, look out for signs of heat, and for that green powder, also for rust where armor is used. Where a lead covering to rubber cables or to paper-covered cables is employed look out for a white powder. Look out for cracks in lead tubes and in bitumen. The green powder is a salt of copper, an oxide or a chloride, and it denotes that the salts from the sea have got at the copper conductor. Rust, of course, shows that it has got to the iron. The white powder shows that the lead is being attacked.

One important caution may be given here. In the case of a lead-protected cable, particularly bitumen insulation, protected by lead; if there is a crack in the lead and a crack in the bitumen inside, as will probably follow, moisture impregnated with salts from the sea will almost surely enter, and there are then the conditions necessary for galvanic action. The copper and the lead and the moisture with the salts form a galvanic battery in themselves. In addition, the electrical pressure being always on the copper conductor there will be a leakage current passing out through the crack, through the moisture, tending to gradually eat away the copper where the conductor is positive, and to gradually eat away the lead where the conductor is negative. In the latter case further secondary action will probably be set up.

Where paper-insulated cables are employed it is of the very utmost importance to examine the lead coverings as frequently as possible. Any crack, or even a pin-hole in the lead, allows moisture from the atmosphere, which is always present between decks in every ship, to penetrate to the insulating envelope. What happens afterwards is usually as follows: The moisture creeps along inside the capillary space which exists between the paper and the lead tube, and it finds out some places in the paper where perhaps it is not fully impregnated with oil, and it proceeds to work its way through these. Gradually the insulation resistance of the cable is lessened and lessened at that point, and at some awkward, inconvenient time a spark passes across from the lead to the cable, or from the cable to the lead, and you have a short circuit between the two.

As mentioned in a former article, also, flexible cords should be very frequently examined. They are the weakest spots of all, and particularly on board ship. Examine them for kinks; examine them for pieces of wire sticking out through the covering; examine them for the deposit of moisture and of the salts from the sea upon any part of them. The flexible cord is a very useful thing indeed. It enables lamps and other apparatus to be employed under conditions that would be impossible without them, but it is a source of great danger. In the first place, if it is of inferior quality when fixed, and in the second place if it is not properly looked after, if it is not frequently examined. The modern flexible cord is again far superior to that of twenty years ago, but it is still liable to the troubles mentioned. It should be remembered that a "short" in a flexible cord may lead very quickly to a fire. The cord itself may become red hot in a few seconds, and almost anything may happen after that.

Design of Self-Propelled Barge for the New York State Barge Canal

In response to the offer made in the June issue of this journal to publish designs or suggestions from our readers which will aid in establishing the best type of barge for service on the New York State Barge Canal, the following information has been submitted by John H. Bernhard, of New Orleans, formerly general manager of the Alabama & New Orleans Transportation Company, which is now operating a fleet of 1,000-ton coal barges for bringing coal from the Alabama coal fields to New Orleans. This project was conceived by Mr. Bernhard, and it was through his efforts mainly that the enterprise was carried out.

The route over which the barges of the Alabama & New Orleans Transportation Company are operated is from New Orleans up the Mississippi River, then through the Lake Borgne Canal to Mississippi Sound, thence through Mobile Bay to the Tombigbee River, up the Tombigbee River to its junction with the Warrior, and up the Warrior River to its junction with the Black Warrior, which is followed to Tuscaloosa, Ala., the terminus of the line. The entire distance is about 500 miles, and the river distance from Mobile to the head of navigation is about 444 miles.

This route has a striking similarity to the new inland waterway from New York to Buffalo, which is up the Hudson River and through the $130,000,000 (£26,650,000) New York State Barge Canal, including Oneida and adjacent lakes. The Mississippi River might be compared with the Hudson River, while the Lake Borgne Canal, whose channel is 8 miles long, 80 feet wide and 8 feet deep, offers the same difficulties to navigation as the New York Barge Canal, with the added limitation that the channel of the Lake Borgne Canal is more crooked.

The Mississippi Sound from Lake Borgne to Mobile Bay might be compared with the lakes which the New York Barge Canal traverses. Then come the Mobile, Tombigbee, Warrior and Black Warrior Rivers, which have been made navigable by the Government after twenty years' development at an expenditure of $8,000,000 (£1,640,000). In this route

Fig. 1.—Alabama Coal Barge Under Way in Mississippi Sound

there are seventeen locks, each 52 feet wide and 285 feet long, most of which have a rise of 10 feet, while one lock has a rise of 63 feet. This river is extremely crooked and difficult to navigate, yet the Alabama & New Orleans Transportation Company, which undertook to move coal from the head of navigation of the river to New Orleans, a distance of 515 miles, has built seven self-propelled barges with a capacity of 1,000 tons each, which have been operated on this route very successfully.

Fig. 2 gives a good view of this river at Demopolis, Ala. In this picture can be seen one of the company's barges moored against the shore unloading salt, while in the background can be seen an old-fashioned stern-wheeler. Difficulties have been encountered in navigating this route with stern-wheel vessels

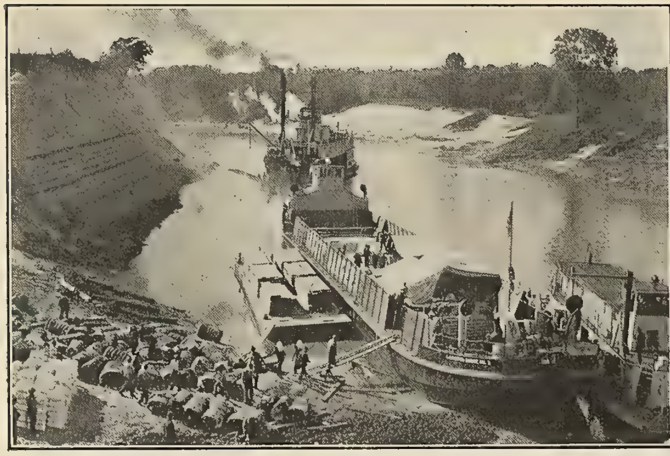


Fig. 2.—Barge Unloading at Demopolis, Ala.

Fig. 3.—1,000-Ton Barge Going Through Lock in Lake Borgne Canal

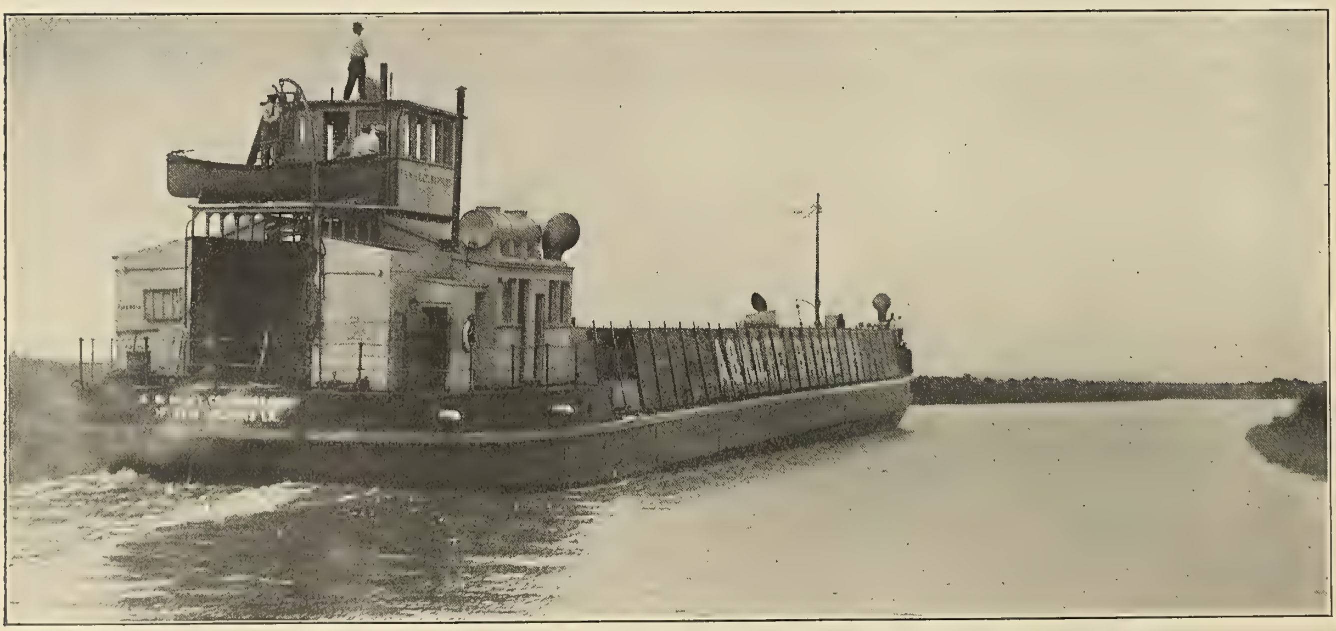


Fig. 4.—Stern View of 1,000-Ton Alabama Coal Barge Entering Lake Borgne Canal at Full Speed

in spite of the fact that the stern-wheeler carries only one-third of the tonnage which the new barges carry. The cost of operation of the stern-wheeler, furthermore, is about four times the cost of operation of the barges.

Self-Propelled Barges of the Alabama & New Orleans Transportation Company

The new barges, a description of which was published on page 467 of the November, 1913, issue of International Marine Engineering, are so simple in construction that they were built practically in the heart of the Louisiana swamps, 14 miles from New Orleans, and most of the work was done by unskilled labor, consisting principally of negroes from the cane fields. Yet the barges are entirely seaworthy, as shown by the fact that on October 22, 1913, three of them were in the Mississippi Sound during a severe hurricane, when two ocean-

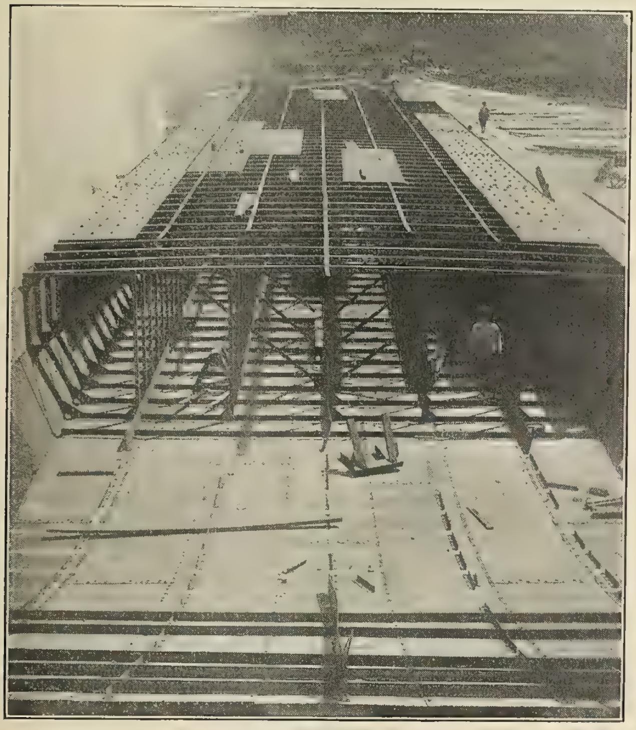


Fig. 5.—Barge Under Construction

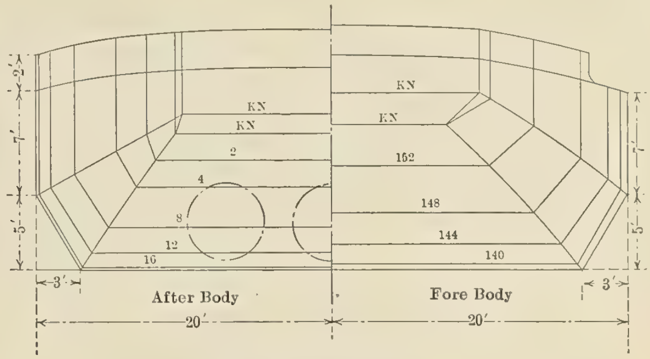


Fig. 8.—Body Plan

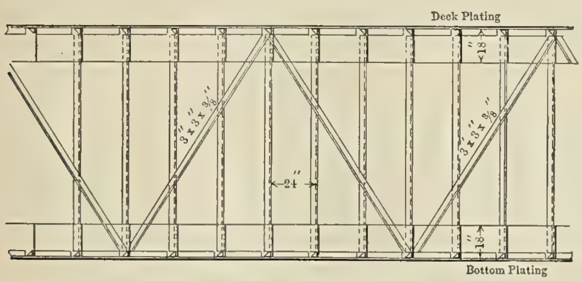


Fig. 6.—Section of Longitudinal Girder

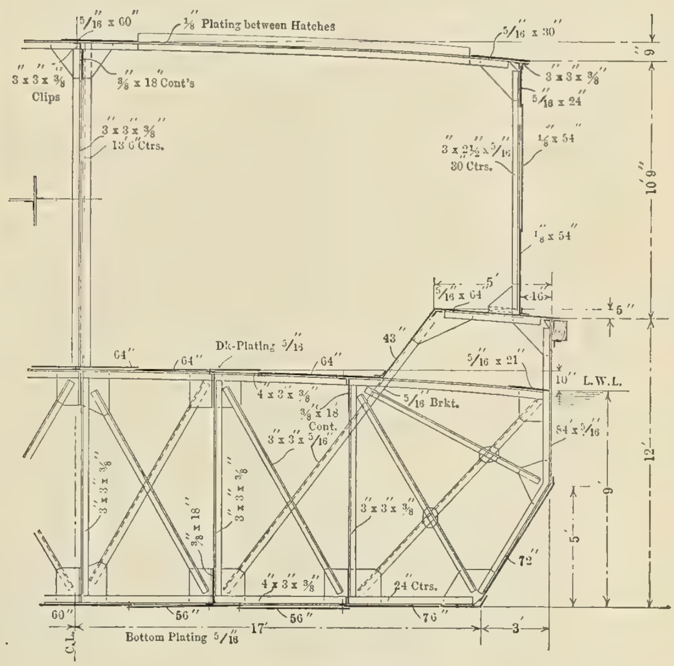


Fig. 9.—Midship Section

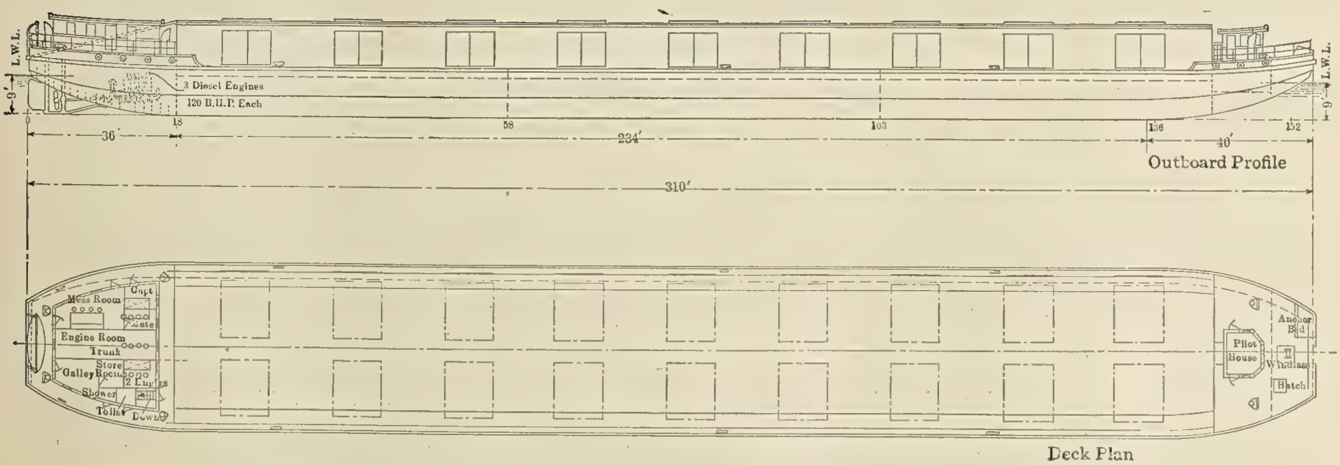


Fig. 7.—Profile and Deck Plan of 2,400-Ton, Triple-Screw Barge Designed for New York State Barge Canal by John H. Bernard

going vessels which were lying in the harbor at Gulfport were damaged, and a Government revenue cutter, which was stationed in the Sound, was obliged to put into Mobile for protection, while the three barges successfully fought out the storm without the least damage to hull or cargo.

The barges are of steel, and are propelled by two 75-horsepower internal-combustion engines, operating on producer gas, which gives them a speed of 7½ miles per hour when empty and 7½ miles per hour when loaded. The fact that the same speed is obtained when the barges are either empty or loaded is due to the fact that when fully loaded the propellers are better submerged, so that what the boat loses in speed through skin friction is gained through the better grip the propellers have on the water. Furthermore, these barges do not "squat." They can enter the narrow channel of Lake Borgne Canal, which, as stated above, is only 80 feet wide and 8 feet deep, and go through this at full speed, with the result that the stern lifts rather than settles. Moreover, the wash of the barge is practically nil.

In Fig. 4 is shown a stern view of one of the barges when moving at full speed in the entrance of Lake Borgne Canal, while in Fig. 1 one of the barges is shown in the open Sound, also at full speed. In both instances the wash is hardly sufficient to rock a rowboat. A barge which produces as little wash as this would undoubtedly mean a saving of millions of dollars to the State of New York in protecting the banks of the canal, and it might also mean an increase in the capacity of the canal of over 50 percent by permitting the barges to run at full speed.

An added advantage to the navigator which this barge has is the fact that it does not swerve. As it is propelled by two propellers, spaced 10 feet apart and steered by three rudders—two wing rudders and one center balanced rudder—it has been found very steady in its movements.

Although built for speed the barge apparently has a clumsy form. This shape, however, has been developed only after years of experiment, and it is a design that has been universally adopted for shallow draft navigation in Holland, more particularly in Amsterdam, a city which is cut up by innumerable canals, all shallow, straight and narrow. Although the Dutch canal boats are designed primarily for canal work, yet the same craft are very often obliged to go, with valuable cargoes, such as rice, sugar, tobacco, etc., into the open harbor of Amsterdam, which is large and wide enough to demand comparatively seaworthy boats.

The barges are very simple in construction, doing away with any special bended plate, their sides having a slant, which, in this case, should be the same as the average slant of the New York Barge Canal. This means that the barge can come closer to shore when receiving or unloading its cargo, and also that the barge can hug the shore closer when going at full speed, which will permit a greater space between similar barges when passing each other in the canal. These barges can turn at full speed over a radius of one and one-half times their own length.

Proposed Barge for New York State Barge Canal

For the New York Barge Canal a similar barge can be designed, which would be very economical and safe to operate, not only through the entire canal and through the Hudson River or Lake Oneida, but also through the Great Lakes. Of course, certain alterations must be made to meet local conditions; for example, the fact that the bridges limit the clearance above the water to 15 feet 6 inches, makes it necessary that under no conditions shall any part of the barge be more than 15 feet above the water.

Fig. 7 shows the general outline of such a barge. The dimensions are: Length, 310 feet; depth, 12 feet at the sides and 12 feet 6 inches at the center; draft, when fully loaded, 9 feet; width of deck, 40 feet, and width of bottom 37 feet. The barge is flat-bottomed, and is propelled by three 120-horsepower Diesel engines. Such a barge will have a net carrying capacity of 2,400 tons and a speed of 8 miles per hour when fully loaded. When empty the barge can be quickly loaded by means of ballast water, which can give the boat any desired draft.

The barge is equipped with three rudders; that is, two side rudders and one center balanced rudder. The pilot house is forward, together with quarters for a crew of ten men. The captain, the two mates and two engineers are berthed aft, where the galley is also located. The cargo box is 12 feet high, 36 feet wide and 265 feet long, inside dimensions. The deck is sunken 3 feet, giving an additional height of 3 feet to the cargo box, so that the total space in the cargo box is 140,000 cubic feet. Since the barge draws only 9 feet of water it will have a freeboard of 3 feet. The bow rises 8 feet above the waterline, while the deck over the engine room rises 2 feet over the main deck.

Such a barge, complete with all machinery, electric lights, winches, pumps, bulkheads, fully equipped, will cost f. o. b. New York State Barge Canal $75,000 (£15,400). Granting for a moment that the canal will be closed six months of the year (which seems to be unreasonable and which will probably be changed to not over four and one-half months, perhaps four months), the cost of operation of the barge figures out, allowing 20 percent for interest, depreciation, insurance and repairs, as a total of $15,000 (£3,080) for each season.

Figuring the speed of the barge at 8 miles per hour, and allowing for the narrow parts of the canal, where the barge can make only 4 miles per hour, and also allowing ample time for loading and unloading at either end of the canal and at intermediate points, the barge ought to make a round trip every week. The barges running from the Black Warrior coal fields in Alabama to New Orleans, a distance of 515 miles, going through seventeen locks, make the round trip, including loading and unloading, and taking into consideration all delays, such as fog, etc., in an average of nine days. So certainly we are making a liberal allowance for delays when we figure on this barge making only one round trip per week, or twenty-five trips per season.

With the above assumptions the total overhead charges per round trip amount to $600 (£123).

Cost of Operation

The 1,000-ton barges running between Alabama and New Orleans have a total crew of seven men for day and night runs—a captain and mate, two deck hands, two engineers and a cook. But to avoid criticism, let us equip this barge for the New York Barge Canal with a crew twice as large, as follows:

1 captain, at monthly salary of	$200	(41/13/4)
2 mates, at $100 (20/16/8) each per month	200	(41/13/4)
2 quartermasters, at $60 (12/10/0) each per month	120	(25/0/0)
4 deckhands, at $40 (8/6/8) each per month	160	(33/6/8)
2 engineers, at $100 (20/16/8) each per month	200	(41/13/4)
2 oilers, at $60 (12/10/0) each per month	120	(25/0/0)
1 cook, per month	40	(8/6/8)
14 men, a total per month of	$1,040	(216/13/4)
or $250 (52/1/8) per trip.		

Figuring the subsistence at 40 cents (1/8) per man for every day of the trip, gives a total subsistence of $14 \times 40 \times 7 = \$40.00$ (8/6/8). The fuel, when using Diesel engines, is very liberally figured at $144 (30/0/2) per round trip. Granting for each trip for supplies, such as oil, waste, ropes, paint, etc., the liberal sum of $66 (13/15/0), we have a total outlay for each trip of $1,100 (£226). Thus for a round trip a barge having a carrying capacity of 2,400 tons will be able to move 4,800 tons for $1,100 (£226), or slightly less than 23 cents (0/11½) per ton.

Assuming that one company uses thirty barges, such a company could move during the open season 3,600,000 tons of freight at a charge of 26 cents (1/1) per ton, and with such charge could cover the cost of operation, have $100,000

(£20,500) for administration purposes and agents' fees, and have besides 6 percent interest on the capital invested. As the average railroad charge between New York and Buffalo is $1.96 (8/2) per ton, this water transportation means a saving per ton of $1.70 (7/1), or approximately 87 percent.

Does Water Transportation Pay?

The above estimates have been very conservative, so that if any criticism is offered even stronger figures can be brought forward. It is safe to predict, however, that with efficient methods freight can be transported from Buffalo to New York at a charge of 25 cents (1/0½) per ton and yield handsome profits at such charge. Three years ago the writer investigated the possibility of freight movement between Lake Champlain and New York, and found that freight could be moved for 22 cents (0/11) per ton even though the barges returned empty.

Although the above figures are based on the assumption that the barges will be idle for six months of the year, that does not mean that even should the canal be closed the barges need be idle. They are sufficiently seaworthy to be sent down the coast to Texas and Louisiana, if so desired, where they can be profitably employed.

The Westinghouse System of Bridge Control

Apparatus for Controlling a Turbine-Driven Ship from the Bridge—The Governing Mechanism, Gages and Speed Indicators

One of the most interesting features of the marine turbine drive developed by the Westinghouse Machine Company, East Pittsburg, Pa., which involves the use of high-speed turbines with a floating frame reduction gear interposed between the turbine and the propeller shaft, is the method by which the turbines can be controlled by the navigator on the bridge as well as by the engineer from the starting platform.

After several months' service on the United States collier *Neptune,* where this system was first installed, the method of bridge control was found to be thoroughly reliable and of distinct advantage in the operation and maneuvering of a ship in an open seaway and in going alongside a dock. Indicators show the navigator on the bridge just what the turbines are set to do and just what they are doing at every instant, while gages show the air and steam pressures available, so that the action of the propellers is always directly under the control of the officer who is handling the vessel.

The medium used for transmitting to the engine room the movements of the control handle on the bridge is air, while the medium used for the actual operation of the relays moving the steam valve is oil.

Details of the Control System

A diagrammatic arrangement of the operating parts of the control system, including the bridge control and steam nozzle valves, is shown in Fig. 3. As will be seen from examining the left-hand part of the illustration, the bridge control lever D' is movable in two quadrants A' and C', with an offset B' parallel to the axis of movement.

When the control lever D' is at B' both the ahead and astern nozzles are closed. The operating handle D' turns a shaft carrying a cam E', which has pressed against it the point of a small valve F'. The valve F' is hollow and closed at both ends, and has two sets of ports, G' and H', the former

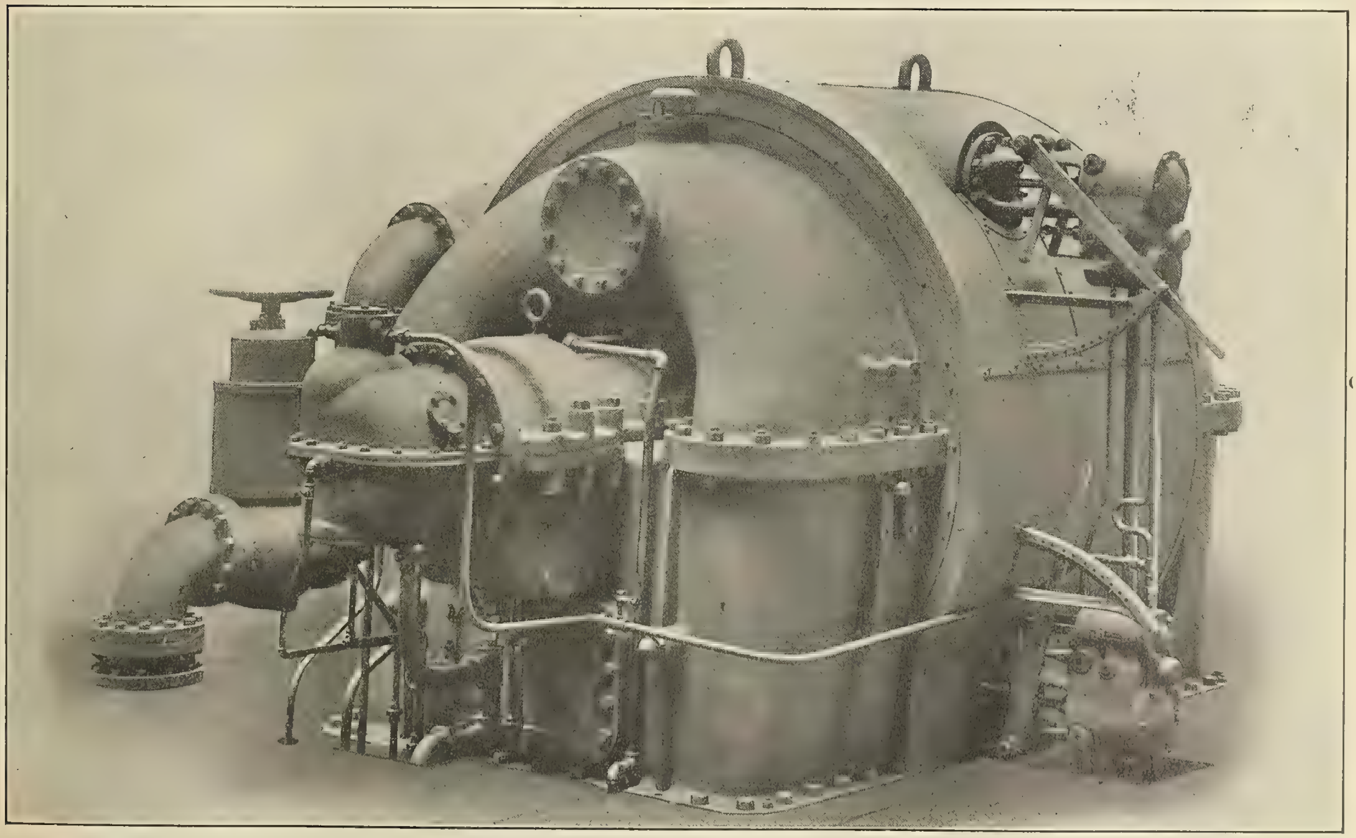


Fig. 1.—Oil Relays for Operating Ahead and Astern Nozzle Valves

always being in communication with the source of high-pressure air supply (furnished by a standard Westinghouse air brake compressor), and the latter having its edge to the extreme left, just line in line with the ports I' in the piston L'. The end of the plunger valve F' is line in line with the left-hand edge of the ports I'. A small spring K' within the piston L' is provided to maintain a positive contact between the point of the plunger F' and the cam E', thus fixing the position of the plunger F' by its point of contact with the cam E'. The movement of the piston L' to the left is resisted by the spring N'. The space J', to the right of the piston L', communicates with space Q' between two diaphragms R' R', and the space to the left of the piston L' communicates with the atmosphere. A communication to the passage within the piston L' to atmosphere is provided by the ports M'.

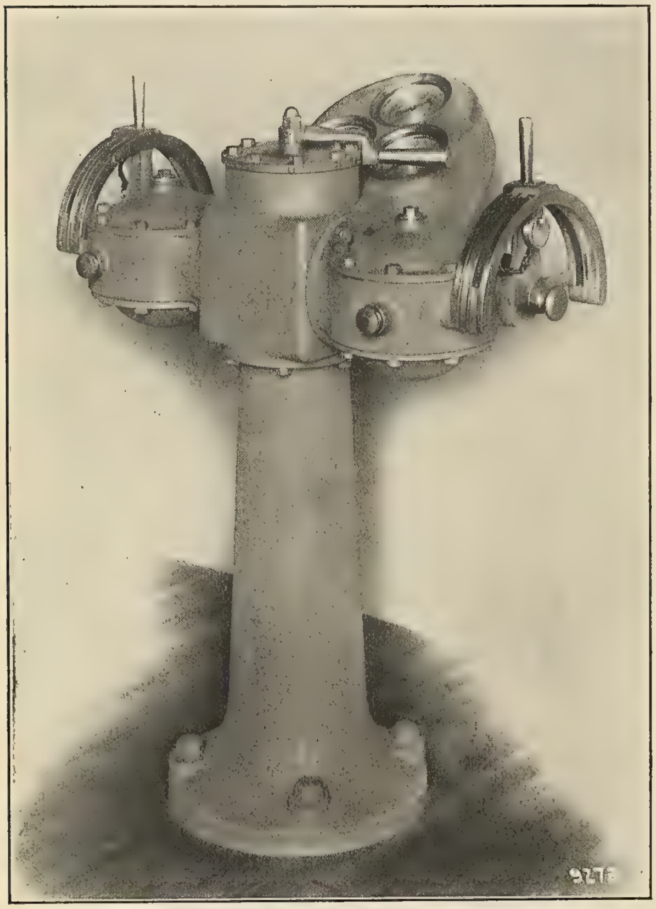


Fig. 2.—Bridge Control Stand

The diaphragms R' R' control two valves, T' and U', the former controlling an opening to atmosphere and the latter an opening to the source of high-pressure air supply. The spaces S' S' are connected by a passage, so that the pressure in them is always equal. The space S' communicates either with the ahead or the astern operating relay in the engine room.

The function of the bridge control valve just described is simply to maintain a predetermined constant pressure in the air relay cylinder, and this is accomplished as follows with the apparatus just described.

Operation

When the lever D' is moved from its central position, B' in the ahead quadrant A', the cam E' pushes the valve F' to the left, thereby bringing the port H' into communication with the port I' in the piston L'. This admits high-pressure air into the space J', and consequently Q'. As the pressure in the space J' increases, it will quickly force the piston L' to the left, until the right-hand edge of the port I' cuts off communication with the port H', or should there be leakage, it will take a position such that the opening through the ports H' and I' would be just large enough to pass sufficient air to make up for the leakage and maintain a constant pressure in the space J'.

Since, normally, the spaces S' S' are at atmospheric pressure, when the pressure between them in the space Q' is increased, the diaphragms are forced outwards, closing the valve T' and opening the valve U', thus admitting high-pressure air into the space S' S' until the pressure in the latter is equalized with the pressure in the space Q', thus bringing the diaphragms back to their normal position, permitting the valve U' to seat and thus cut off the supply of high-pressure air. The pressure existing in the space S' is transmitted to the space P to the left of the air relay cylinder in the engine room.

As in the case with the piston L' and the ports I' and H', should there be leakage in the piping system communicating with the space S', the diaphragms R' R' will be distended slightly, thus holding the valve U' open sufficiently to make up the leakage and maintain constant pressure. Conversely, it is evident that if the pressure in the space J' should increase above that predetermined for a given position of the piston F', the piston L' will move to the left, and open communication between the space J' and the inside of the piston L', thus exhausting air from the space J' to atmosphere through the port M'. This condition also arises when operating lever D' is moved towards the off or central position, which permits the movement of the valve F' to the right. In the latter case the pressure in the space Q' will be decreased and become less than the pressure in the spaces S' S', causing the diaphragms R' R' to collapse and open the valve T' to atmosphere until the pressure in the spaces S' S' is decreased to that in the space Q'.

When the control lever D' is to be moved to the astern position, it is necessary to move it in the direction of its axis of rotation in the slot B'. When this is done an arm W', held between two collars on the cam shaft, moves the small slide valve X' to the right, and brings the pipe Z' to the astern air relay cylinder into communication with space S', and the pipe Z'' into communication with the atmospheric exhaust.

From the above it will be seen that it is impossible for the operator to become confused and accidentally move the control lever in the wrong direction, or try to put it in both the ahead and astern position at the same time, as it is necessary to move the controlling lever sideways before it can be moved from one position to the other.

The Governor

The governor, which controls the speed of rotation of the turbine shaft, is shown on the right of the diagrammatic sketch, Fig. 3. As will be seen, it is of the common fly-ball type, and is driven through the turbine shaft by a worm E and wheel D. The only movable part of the governor is the hollow spindle B, having the ports N and H in it. The movement of the spindle B is restricted by a diaphragm K, to which it is attached. The upper side of the diaphragm is open to atmosphere, and the space below G is filled with oil.

High-pressure oil at about 65 pounds gage per square inch is admitted to the revolving spindle B through the ports A.

When the governor spindle is revolved by the turbine shaft the balls M M are thrown outward by centrifugal force, thus pulling the spindle B downward against the resistance of the diaphragm K, opening communication through the port H in the spindle, and I in the upper spindle bushing, to the space G, the latter communicating through a port L to a pipe connected to the space N of the air cylinder relay.

As the pressure in the space G, below the diaphragm K, increases, it resists the downward thrust of the spindle B,

due to the centrifugal action on the governor weights until the upward pressure on the diaphragm exactly balances the downward thrust of the spindle, thus permitting the upward movement of the spindle *B* by the elasticity of the diaphragm *K* until the communication through the ports *H* and *I* is cut off. Thus it is evident that for any given number of revolutions of the governor spindle there must be a constant fixed pressure of equilibrium in the space *G* below the diaphragm. Should the pressure in the space *G* exceed that corresponding to the speed of rotation of the governor at any instant, the spindle *B* will be forced upward, thus opening communication between the space *G* and the atmosphere through the ports *N* in the governor spindle body.

Air Relays

In the center part of the diagrammatic sketch is shown the air relay cylinder, relay valve and operating cylinder, which control the opening and closing of the nozzles of the turbine according to the speed of rotation desired. Referring to this part of the illustration, and starting with the turbine at rest, the piston *Y*, which opens and closes the nozzle valves, is at the farthest end of its travel to the right, and all the turbine nozzles are closed. When air from the bridge control valve is admitted to the space *P*, to the left of the air-operating cylinder, the piston *Q* will be forced to the right against the resistance of a small spring, thus carrying the relay plunger *O* with it. The movement of the latter establishes communication between the space *R*, supplied with high-pressure oil, and the space *X*, to the right of the piston *Y*, and the space *W*, to the left of the piston *Y*, is brought into communication with the space *T*, and thereby with the oil return to the reservoir, which is open to atmosphere. Thus the piston *Y* will be forced to the left by the oil pressure and through a rack engaging with the gear cut in the periphery of the nozzle valve, will rotate the latter and open the high-pressure nozzles, thus admitting steam to the turbine. As there is nothing to resist the motion of the piston *Y*, nozzles in excess of those necessary to give the desired speed are opened instantaneously, and thus the turbine begins to speed up very rapidly. Now, however, as the turbine gains speed and the governor revolves, the governor spindle *B* is forced down and high-pressure oil is admitted through the ports *H* and *I* and through the passage *L* to the space *N* to the right of the piston *Q*, thus tending to push it to the left against the air pressure in the space *P*. As the piston *Q* moves to the left it carries the relay plunger *O* with it, and when the oil pressure in the space *N* balances the air pressure in the space *P*, or, in other words, the space *J'* in the bridge control valve, the piston *Q* will take a fixed position, and the piston *Y* will take up a position such that the ports communicating with *W* and *X* are both closed, thus maintaining a constant speed of revolution.

Should the turbine tend to exceed the speed fixed by the air pressure in the space *P*, the piston *Q* would move to the left and bring the space *X* into communication with the space *S*, connected to the oil exhaust, and the space *W* would be brought into communication with the space *R*, supplied with high-pressure oil. This would cause the piston *Y* to move to the right until sufficient nozzles had been shut off to reduce the speed, until the oil pressure in the space *N* was again brought into equilibrium with the air pressure in the space *P*.

"Cut-Out" Valve

The bridge operating stand which supports the bridge control valves is shown in Fig. 2, from which it will be seen that there is a rotary slide valve on top of the stand between the port and starboard control valves. This latter valve is not shown in the diagrammatic sketch previously described, and is not shown in detail because of the difficulty of showing the various ports in it. Its function, however, is to permit operating both turbines, either ahead or astern, by either the port or starboard control valve, or to cut out both the starboard and port control valves. In addition to these functions which this valve performs on the bridge control stand, the similar valve on the control stand in the engine room has a position for cutting out the bridge stand and other operating stands in other portions of the ship. Thus when the control system on the bridge is connected, all control stands excepting that in the engine room are made inactive, while if the stand in the engine room is being used all other stands (including the one on the bridge) are disconnected. This arrangement avoids interference, permits rapid changes from one station to another, but always leaves the engine room stand operative in case of an emergency.

Ordinarily, except when maneuvering, the bridge stand is always connected up so that both turbines are controlled by moving either the port or starboard control levers, which simplifies the operation and permits controlling both turbines

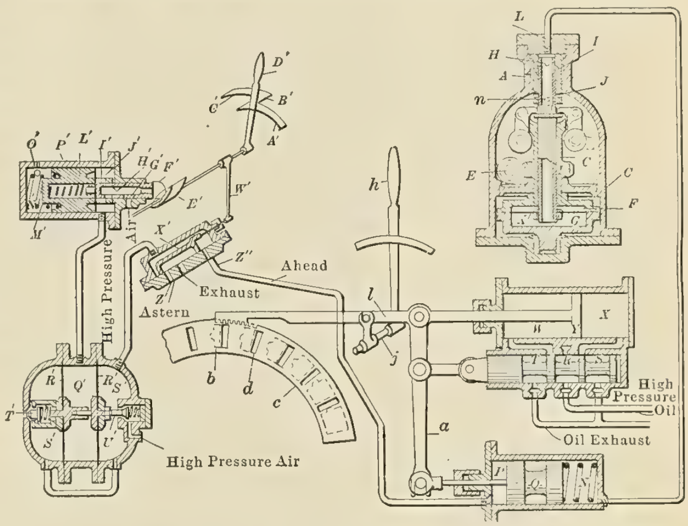


Fig. 3.—Diagrammatic Arrangement of Bridge Control and Nozzle Valves

if either the port or starboard operating valves should for any reason become temporarily disarranged.

In addition to the standard screw-down valves on the ahead and astern turbines, each turbine is provided with a hand-operating device, by means of which a nozzle valve can be moved by hand, if necessary or desirable.

This is accomplished by the lever *h*, as shown in the diagrammatic sketch, Fig. 3. The lever is pivoted on the shaft *j*, and has a lever engaging with the crosshead on the valve-operating piston rod *l*. The latter lever is fitted with a latch so that it can be quickly connected or disconnected when not in use.

As previously pointed out, there may be a number of operating stations from which the turbines can be controlled when this is desirable, as, for instance, there might be considerable advantage in the case of battleships in having the turbines controlled from the central station as well as from the bridge and starting platform.

Gages and Indicators

In order that the officer on the bridge or navigator can see that the turbines are operating as desired, and also to show that the control system is in operating condition, gages are provided which show the steam pressure in the boilers, the air pressure in the control system, the air pressure in the pipe lines *Z' Z''*, as well as the pressure in the oil supply system, and the pressure of the oil under the pistons of the floating frame on the reduction gears.

As it would be frequently necessary to have the piping communicating from the engine room to the bridge in exposed places where it would be liable to freeze, and because of the

difficulty of allowing for the hydrostatic head in the pipe between the bridge and the engine room in the case of liquids, the steam and oil pressures are indicated on the bridge by means of compressed air and a small relay valve, such as illustrated in Fig. 4. As the steam pressure or oil pressure to be indicated on the bridge may exceed the air pressure available, the former are reduced in some ratio, such as 2 to 1 or 3 to 1, as required.

In Fig. 4 the orifice *B* is connected to the steam or oil line, and the pressure desired is indicated on the bridge by the air pressure in the pipe connection to *F*, which communicates with the gage on the bridge. The operating element of the relay consists of the plunger *L A*, having *L* and *A* the same diameter, or *A* a smaller diameter than *L*, for relaying oil or steam pressures. The plunger *L A* is fitted in a bushing, having ports *G* and *H*, port *G* communicating with the high-pressure air supply and port *H* communicating with atmosphere.

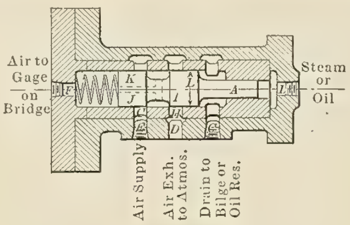


Fig. 4

A drain *C* is also provided, which may either drain to the bilge or to the oil reservoir when oil pressure is being relayed.

Normally, when not being used, the small spring pushes the plunger *L A* to the right, and the gage on the bridge is then connected to atmosphere through the ports *K* and *H*. When steam or oil under pressure is admitted at *B*, the plunger *L A* is forced to the left against the resistance of the spring, and the edge *J* of the plunger *L A* moves over the port *G* and admits high-pressure air through the port *K* to the gage on the bridge, the pressure in the space to the left of the plunger *L A* increases, until the pressure times the area of the left-hand portion of the plunger *L A* equals the pressure times the area on the right-hand portion of the plunger *L A;* thus if the diameter of plunger *L* is twice the diameter *A*, the area of the large end of the plunger will be four times that of the small end, and the actual pressure maintained on the left-hand side of the plunger will be one-fourth of that maintained on the right-hand side of the plunger, thus 200 pounds gage steam pressure would be indicated on the bridge by 50 pounds of air pressure. The oil pressures are transmitted to the bridge in the same way.

Speed Indicators

As was pointed out in describing the operation of the controlling system, there is a fixed pressure (for any given number of revolutions per minute of the turbine shaft) in the spaces *Q'* and *S' S'*, as well as under the diaphragm *K* in the governor spindle and the space *N* to the right of the air-operating cylinder. Consequently, instead of graduating the gage recording the air pressure in the space *S'* in pounds, this scale may conveniently be graduated to read revolutions per minute, so that those in charge on the bridge can see every instant exactly the number of revolutions which the propellers are making.

Another novel feature of the new control apparatus used on the U. S. *Neptune* is a set of speed recording instruments. As previously mentioned, for any given turbine speed there will be a definite oil pressure under the diaphragm *K* of the governor, and consequently this pressure can be used to indicate the speed of the turbine and propeller.

Pressure gages of the recording type may be used, showing the speed, direction of rotation and period of operation of each turbine under any given conditions. These records furnish an accurate log which is indisputable in case of a controversy regarding the speed or manner in which the turbines were operated. These cards can be graduated to read revolutions or knots, as desired.

The Present Position of the Marine Gasoline (Petrol) Engine

BY L. B. CHAPMAN, A. M. I. N. A.

A great deal has been written about the progress of the automobile engine, and the various phases of its development have been kept constantly before the public. The marine engine, on the other hand, has been given very little attention, and a systematic analysis of it has never been attempted. In this article a few of the characteristics will be taken up and considerable comparative data presented, mostly in the form of curves. This information shows clearly what has been accomplished in this field and some comparisons of the marine and automobile types are presented. The data should be of great value to the naval architect, engine designer and purchaser, and is worthy of considerable thought and study.

As will be shown shortly, the marine type of engine presents a great diversity in designs as compared to the automobile engine. The reasons for this are easy to understand. The automobile engine builder went to work in a serious and scientific manner to perfect the gasoline (petrol) engine, while the marine engine builder went at it by the "cut-and-try" method, adopting the important details from the automobile engine. Let us consider the various curves in detail.

Price

Fig. 1 shows curves of prices of twelve representative engines plotted against horsepower. Catalogue prices could not be used direct on account of the wide discounts allowed by

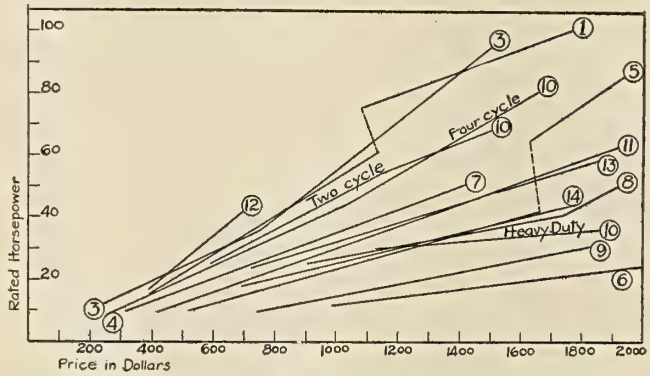


Fig. 1.—Price Includes Engine, Ignition, Etc., Propeller, Gear, and Bosch Magneto

the various manufacturers, but were corrected by the discounts allowed, which were obtained directly from the manufacturer, and in every case include the same equipment. Thus all the engines are reduced to a common basis of comparison. It was found that the prices of each make of engine fell very nearly on a straight line, thus showing that prices vary directly with the horsepower; but each make having a different rate of increase, as shown by the slopes of the lines in Fig. 1. This series of curves shows an almost unbelievable wide variation in prices; thus a 50-horsepower engine, for instance, varies in price anywhere from $900 to $1,800 (£183 to £370). Even wider variations than this can be found by an inspection of the curves. It would be hard to explain such wide variations in price, especially in view of the keen competition in this field. No doubt some of the variation is due to overrating and underrating of the power, but this could only account for part of the wide variation. In view of the fact that

all these engines are well-known makes, and to all appearances of equal merit, the subject of prices is worthy of careful investigation. This curve sheet is presented not for its particular value but simply to show the general trend of prices and the unsettled condition in this field.

Weights

Fig. 2 shows curves of weights per horsepower of twenty-one makes of engines. It was found upon careful investigation that the weights per horsepower varied with the horsepower and with the revolutions, the high-speed engines, of

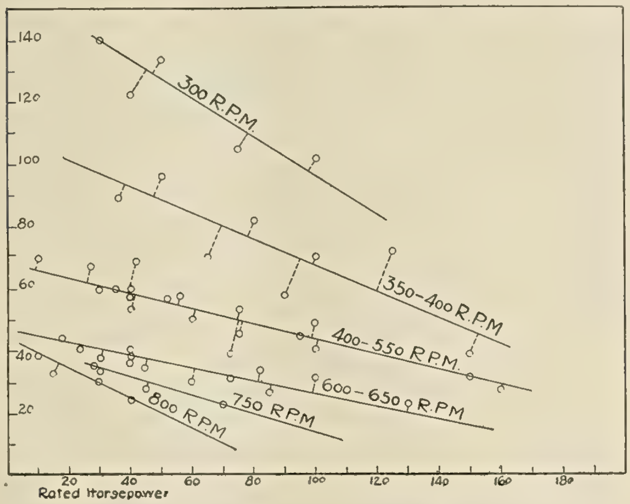


Fig. 2.—Weights of Marine Engines With Reverse Gears; Twenty-one Makes Represented

course, being of a lighter design. Fig. 2 shows the results obtained from the data available, the points representing the various engines falling fairly well on the lines drawn. Thus all the engines selected running between 400 and 550 revolutions per minute fell very nearly on one straight line, the weight per horsepower falling off from 65 pounds to 35 pounds as the power increases.

Fig. 3 shows the weights of high-speed marine engines and covers this field very thoroughly. The results are presented

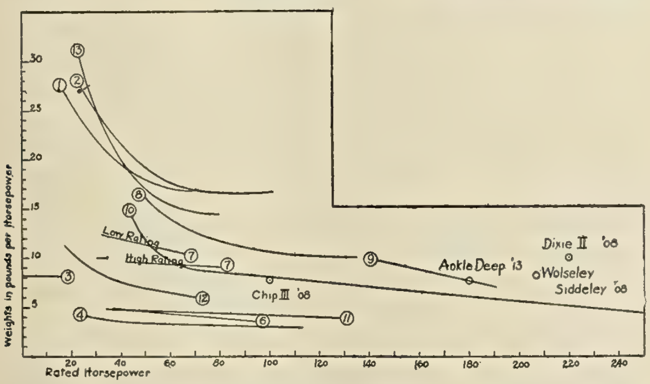


Fig. 3.—Weights of High-Speed Engines: (1) 1,000, Part Aluminum with Gear; (2) 900, Medium Speed with Gear; (3) 950, Canoe Motor; (4) 950 to 1,200, Revolving Aero Motors; (6) 1,000 to 1,600, Vertical Aero Motors; (7) 1,000, High-Speed without Gear; (8) 1,100 to 1,200, High-Speed with Gear; (9) 1,200, High-Speed with Gear; (10) 850 to 1,100, Two-Cycle without Gear; (11) 1,000, Two-Cycle without Gear; (12) 1,000 Two-Cycle without Gear; (13) 1,000, Medium Speed with Gear

a little differently here than in Fig. 2. Here each curve represents a particular make of engine and not a collection of various makes as in the other figure. Thus No. 10, for instance, represents a two-cycle make with revolutions per minute varying between 850 to 1,100, depending upon the horsepower. Another point that should be noticed is that some of the curves are for engines with reverse gears and some for engines without, and, of course, are not directly comparable. Curves 4 and 6 are for aero engines, and represent the general practice in this field, and give an interesting comparison with the other engines on the sheet. Curves 1, 2 and 13 are semi-speed engines, and are really intermediate between those given in Fig. 2 and the purely high-speed racing engines. A few scattered points are given showing the engine weights of some of the notable racers.

Brake Mean Effective Pressure

By an analysis of all the available brake-horsepower tests of gasoline (petrol) engines, the marine engine appears to be slightly lower in power than the aero and automobile engines for given bore and piston speed. Thus for four-cycle marine engines the brake mean effective pressure varies from 53 to 83 pounds per square inch, the largest proportions of the tests have a mean effective pressure close to 70. Some engines built especially for racing show higher values than this, the highest reliable value being 91 pounds per square inch. By taking catalogue ratings and solving back for mean effective pressures, about the same run of values are obtained as found by the brake tests.

A great many reliable tests on automobile engines show values of 90 to 100, and values as high as 107 have been obtained. Aero engines, while not, as a rule, as high as this, still surpass the marine engine. No doubt there are some marine engines that have a mean effective pressure as high as those quoted for automobile engines, but the general average appears to be much lower, and values for automobile engines seldom run as low as 55 and 60, which are frequent in marine practice. More data are needed along this line before any conclusion can be drawn, but the data available show up the marine engine in rather a poor light. No doubt this superiority of the automobile engine is due to the scientific methods of design as opposed to the "cut-and-try" method of the average marine engine builder.

Why engines vary so greatly in mean effective pressure, of course, is open to question. Such points as valve areas and lifts, compression, areas of passages, timing of valves and adjustments of the carburetor, are, of course, the main causes, and have not been given enough study by many of the makers. When two engines of the same bore and piston speed show mean effective pressures of 51 and 83, respectively, during a

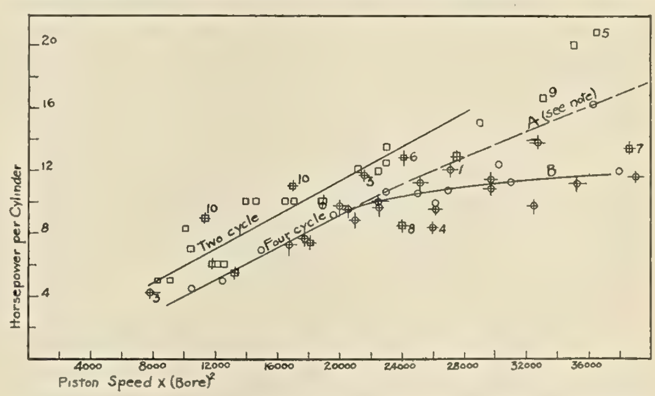


Fig. 4.—A Comparison of Two and Four-Cycle Marine Engines. Squares indicate two-cycle engines as rated (14 makes represented); squares with cross indicate two-cycle brake tests (4 makes represented); circles indicate four-cycle engines as rated (8 makes represented); circles with cross indicate 4 cycle brake tests (14 makes represented). Note A—Dotted line has a number of points beyond the sheet, including brake tests. All points shown are at approximate rated horsepower

competition test, evidently there are still considerable unknown elements in the design. Further information on this subject will be brought out shortly in connection with Figs. 4* and 5. First let us turn our attention to the consideration of the two versus the four-cycle engine.

* The source of much of the data in Fig. 4 is from United States navy tests and the proceedings of the Institution of Automobile Engineers.

Two Versus Four Cycle

From the definition of the cycles the two-cycle engine has twice as many working strokes as a four-cycle engine for a given revolution per minute. Theoretically, then, for the same bore and piston speed the two-cycle engine should develop twice the power that the four-cycle does. This is often the popular opinion, although far from the case, as we shall see shortly. Let us turn our attention to Fig. 4. In these curves the horsepower per cylinder is plotted against piston speed × bore² for a large number of engines. Two lines are drawn, one representing the average of the four-cycle points, and one representing the average of the two-cycle points. These curves then give a true comparison of horsepower, and are, of course, proportional to the mean effective pressures. The various points can be distinguished, the squares representing the two-cycle engines and the circles the four-cycle engines. To make the data as complete and valuable as possible, many catologue ratings as well as all available brake-horsepower tests were plotted. The brake-horsepower tests, all of which are highly reliable, are distinguished from the others by a cross. This figure shows very clearly that the two-cycle engines develop very little more power than the four-cycle for same conditions of piston speed and bore. This, of course, means that the mean effective pressure of a two-cycle engine is little better than one-half that of the four-cycle; that is, the average mean effective pressure is about 35 to 40. Some tests show slightly better than this, but more often they run down in the neighborhood of 30. The cause of this is, of course, due to the poor scavenging of the two-cycle engine. As the scavenging in marine engines is done by the new charge, we would naturally expect an excessive fuel consumption in this type. This, however, is not the case, as the two-cycle engine shows as good, and often better, fuel consumption than the four-cycle engine.

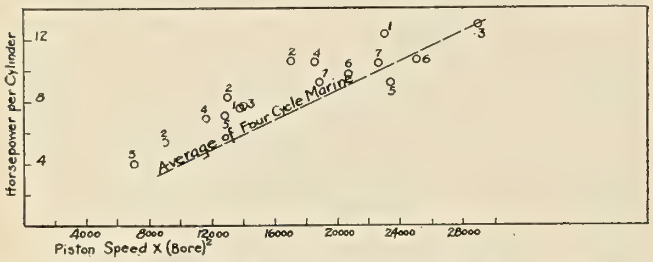


Fig. 5.—Comparison of Marine and Automobile Engines. Circles Indicate Automobile Engine Brake Test

The makers have purposely lowered the mean effective pressure of the two-cycle engines by using smaller ports and a smaller fuel charge in order to obtain good fuel economy. It would thus seem that the two-cycle engine has no place except in small one and two-cylinder engines, where more uniform torque is desired, and in order to reduce the valve mechanism and simplify the moving parts.

Fig. 4 brings out another interesting feature worthy of considerable thought; that is, the falling off of the curve marked *B* above 10-horsepower per cylinder. This is no doubt caused by trying to make a given cylinder develop more power than it is able to; that is, the engines are overrated and are forced in order to produce their power. There are a number of points (some off the sheet as mentioned in note A) that fall on the dotted continuation of the curve marked *A*. These engines, although comparatively few, are no doubt better designed and more fitted to deliver their rated power than those on *B*. The mean effective pressures can be found from these curves by dividing the ordinate reading by the corresponding abscissa and multiplying by 16,800 for four-cycle engines and by 8,400 for two-cycle engines. These two curves not only form a basis for comparison of existing engines but should furnish data for design work.

Fig. 5 shows data of the same nature for automobile engines. The four-cycle marine engine curve is transferred from Fig. 4 for comparison. All the points shown are from brake tests. These points all fall above the marine engine curve, as would be expected from what has been said previously regarding mean effective pressures. If a curve were drawn for these points it would fall off at its upper end the same as *B* in Fig. 4. In this case it is due directly to driving the engine at too great a power. The upper points in every case are for the same engines as shown lower down on the curve, but driven at higher revolutions per minute.

Fuel Consumption

A point of extreme importance in all engines, of course, is fuel consumption, and although reliable data are scarce, and no curves can be drawn, a few words should be said at this point regarding it. Fuel consumption tests of sixteen marine engines, all using the same quality of gasoline (petrol), showed a range of 0.8 to 1.5 pints per horsepower per hour, with the average figure about 1.3 pints. These engines were all on a competitive test, and, of course, were supposed to be adjusted and in A-1 order. From an exhaustive study of fuel consumption tests by the writer and others, no definite cause can be found for the wide variations in fuel consumptions. No doubt some of it is due to the quality of fuel and adjustments, but probably most of it is due to poor designing. Automobile engines on the test block invariably show better results than this, values as low as .80 pint per horsepower are common, and figures as low as .65 are not infrequent with a good grade of fuel.

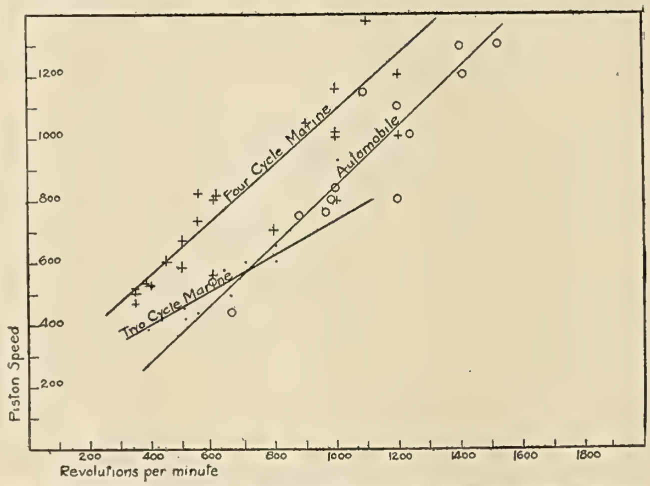


Fig. 6.—Circles Indicate Automobile Engines. Crosses Indicate Four-Cycle Marine, and Dots Indicate Two-Cycle Marine Engines

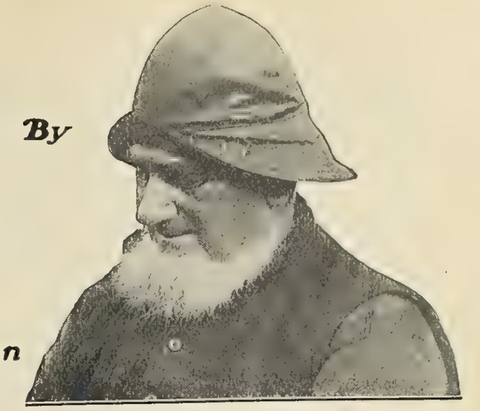
As mentioned earlier the two-cycle engine shows practically no difference from the four-cycle except in engines of extremely poor design.

Piston Speed

Fig. 6 shows in the form of a curve the present practice in piston speeds both in marine and automobile engines. Contrary to common belief, the marine engine shows a higher piston speed than the automobile engine for the same revolutions per minute. A curve showing the current practice in two-cycle work is also included.

In conclusion, it appears that the automobile engine is slightly further advanced than the marine engine. Little has been said about the aero engine, but in weight, fuel consumption, mean effective pressure and refinement of design, it also exceeds the marine type. The writer has endeavored to bring out a few of the important points, but many important considerations, such as valve arrangements, sparking mechanism and cylinder arrangement, etc., in which it is known that the automobile and aero type exceed the marine type, have been left out.

Economy Talks By "Old Scotch"



A Few Facts About the Chemistry of Combustion

Well, brother marine engineers, the editor of this magazine has given me a license to go ahead with the line of "dope" I handed out to you in the last number, so I am going to devote a few hours each month for some time to come in making good my statement that you can all save money for yourselves, as well as for the owners, by exercising a little more attention to business here and there.

Of course, the boilers are the chief villains in this play, and, as I was telling you last month, it is here that we must look for the escape of the little heat units from the coal we shovel in the furnaces, and see how they escape and what we can do to prevent some of them from getting away at this point.

The elements in the coal which we shovel in the furnace doors are principally carbon and hydrogen so when you hear highbrows talking about hydrocarbons, they simply mean a gas mixture containing those two elements. While the carbon and hydrogen cost money when we buy them in the form of coal, the other necessary element—oxygen—comes free and in abundant quantities with the air. You know this oxygen is really about the most important old gas in the business, and with furnaces the proper regulation of the oxygen as it enters with the air is the principal thing we have to look after in our scramble to burn coal properly and save that 10 percent I am telling you about.

Air contains about 23 percent of oxygen, the remaining 77 percent being nitrogen. We'll forget the latter, as it doesn't figure in the combustion very seriously, anyhow. You may not think that air weighs anything; it does, just the same, but it takes 12½ cubic feet to weigh one pound. To have enough oxygen to combine properly with the carbon and hydrogen in the coal requires on the average about 235 cubic feet of air let into the furnaces for every pound of coal burned. As I said before, it's a good thing we don't have to buy the air at the same rate we pay for coal. When the coal is first thrown on the fire it does not burn immediately, but is baked, we might say, the same as they bake it in a gas retort, and the carbon and hydrogen are driven off in the form of gases. As these same gases arise in the furnaces they meet with the air, which has come up through the grates, and if everything is agreeable for the wedding they unite with the oxygen in the air, the hydrogen going first, as Old Mr. Oxygen seems to prefer that young lady, and the carbon gets attended to next. This union of these elements must be accomplished under very pleasant conditions to all three parties. There must be just the right amount of air and it must be at just the right temperature. You might think from the fuss made it was an old maid drinking tea. If there is not enough air to go around, the carbon suffers and is liable to drift away, either in the form of smoke or else by attaching itself to the fire surfaces in the form of soot. If the air is not sufficiently warmed up the hydrogen and carbon only half-heartedly unite and much of the good effect of the union is lost in the form of water vapor. On the other hand, should the hydrogen and carbon liberated from the coal be excessively heated, they do not unite freely with the oxygen in the air and certain portions of them pass up the stack in their original form.

The formation of smoke indicates imperfect combustion, as the black clouds passing out the funnels are largely composed of small particles of unconsumed carbon. This waste should, of course, be prevented as much as possible, although in smoke itself the loss is rather immaterial. It is the bad condition of the combustion, indicated by the smoke, which causes the greater losses. The burning of the hydrocarbons shows clearly that air must be let into the furnaces and combustion chambers above the fire as well as beneath it. After the hydrocarbons are liberated, what remains of the coal is in reality like the coke we buy from the gas companies, and it consists almost entirely of pure carbon. This carbon unites with the oxygen forced by the draft up through the burning coal. The oxygen in the air unites with this carbon in what might be termed a natural proportion; that is, one atom of carbon grabs hold of two atoms of the ozygen and forms what is known to the chemical trade as carbondioxide, or carbonic acid gas; to ordinary fellows, like us marine engineers, it is the same stuff that makes soda water sizzle, and produces that flare-back in your nose when you are foolish enough to drink soda water.

In this proportion one pound of carbon absorbs two and two-third pounds of oxygen, and that is the real thing in combustion, or combustion according to Hoyle. But—the pesky stuff gets gay as it reaches the colder layer of fuel on top of the fire and absorbs more carbon, just as a West street longshoreman absorbs schooners of suds on a hot day, and the result is a new mixture in the proportion of one pound of carbon to one and one-third pounds of oxygen. This is the same "pizen" stuff that we smell as coal gas around an anthracite stove when we are huddled up around it in a poorly ventilated room in the winter. Highbrows call this mixture carbon monoxide, and it is about as bad for combustion as the coal gas is for your lungs. If this stuff escaped unburned there would be a big loss of heat units right there, but fortunately when it breaks through the burning coal and runs into more air an additional amount of oxygen is absorbed, so that it is transformed into carbon dioxide, or CO_2, as the chemists call it, and then real combustion takes place. This illustrates again the necessity of having air put in the furnaces above the grates.

Now, perhaps you do not think all this line of talk I have given you amounts to anything, but believe me, a knowledge of this little chemistry of combustion is a very important proposition, and I can name two ships right now where a careful study of these conditions and the proper regulation of the three elements produced a saving of 10 percent in the fuel. I am going to show just how it was done later on, and if any of you don't believe it can be done, sent a five-spot and I will cover it with an equal amount of my hard-earned wages.

Yours for economy,

Old Scotch

The Watertight Subdivision of Ships and the Effect of Bilging—IV

BY A. L. AYRE

Change of Trim Due to Bilging

This is an extremely important question, especially in the case of bilging of end compartments, as it may frequently happen that the deck at the end of the vessel will become level with the water, as shown in Fig. 8, or perhaps submerged, and the vessel rendered unseaworthy. The question of trim may be considered in the following form:

In Fig. 13 it is seen that owing to the loss of buoyancy in way of the compartment $x\ y\ X\ Y$, the mean sinkage produced the waterline $W_1\ L_1$, but at this waterline the center of buoyancy has moved aft to the position B_1 owing to the withdrawal of the buoyancy at the fore end and its addition in the layer contained between $W\ L$ and $W_1\ L_1$. The horizontal distance $B\ B_1$ represents a couple tending to trim the vessel in a forward direction, and its value can be found as follows:

Let v = the volume of either lost buoyancy or the added layer.
d = the horizontal distance from the center of gravity of the buoyancy contained in the bilged compartment to the position of the center of gravity of the buoyancy contained in the added layer.
And V = the volume of displacement.

Then

$$B\ B_1 = \frac{v \times d}{V}.$$

This couple multiplied by the total weight of the vessel will give the trimming moment. If the lost buoyancy is taken in tons, then the trimming moment can also be found by multiplying its amount by the distance d. Having found the trimming moment, this can be divided by the moment to change trim 1 inch ($M.\ C.\ T.\ 1''$) and the total amount of trim obtained.

$$M.\ C.\ T.\ 1'' = \frac{W \times G\ M_2}{L \times 12}.$$

Where W = total weight or displacement in tons.
$G\ M_2$ = longitudinal metacentric height.
L = length of vessel in feet.

It will be seen that for the new condition $G\ M_2$ will have altered, on account of the new shape of the displacement and the intact waterplane on both of which it is dependent, seeing that the height of M_2 is determined by longitudinal moment of inertia about the center of flotation, divided by the volume of displacement = $B\ M_2$, *i. e.*, $I_2 \div V = B\ M_2$. The value of I_2 will have been greatly affected owing to the difference in shape and area of the waterplane $W_1\ L_1$, as compared with $W\ L$, while the position of B will have altered in an upward direction. The moment of inertia of the waterplane $W_1\ L_1$ will be found by first of all calculating the moment of inertia about the center of flotation ($F_1\ F_2$) of same, without having taken into account the lost area in way of the bilged compartment, and corrections afterwards made for the damaged portion as follows:

I_d (the moment of inertia of the portion $x\ y$ about $F\ F$) = $I_a + A\ d^2$, where I_a is the moment of inertia of the $x\ y$ portion about its axis $a\ a$; A is the area of the $x\ y$ portion, and d is the longitudinal distance between $F\ F$ and $a\ a$. Then the moment of inertia of the complete waterplane, taken about the axis $F\ F$, being reduced by the amount of I_d, gives the moment of inertia of the damaged waterplane about $F\ F$. A further correction is, however, necessary because the axis $F\ F$ is one for a complete waterplane, while the moment of inertia is required for the waterplane in the damaged condition. We must next, therefore, find the center of flotation of the damaged waterplane, this being shown by $F_1\ F_1$ in Fig. 13, the distance aft of $F\ F$ being y. This second correction, which is also a deduction, is equal to the area of the intact waterplane $\times\ y^2$, and the actual longitudinal moment of inertia of the damaged waterplane $W_1\ L_1$ is then obtained about its own center of flotation. Dividing this corrected moment of inertia by the volume of displacement we obtain the new value of $B_1\ M$.

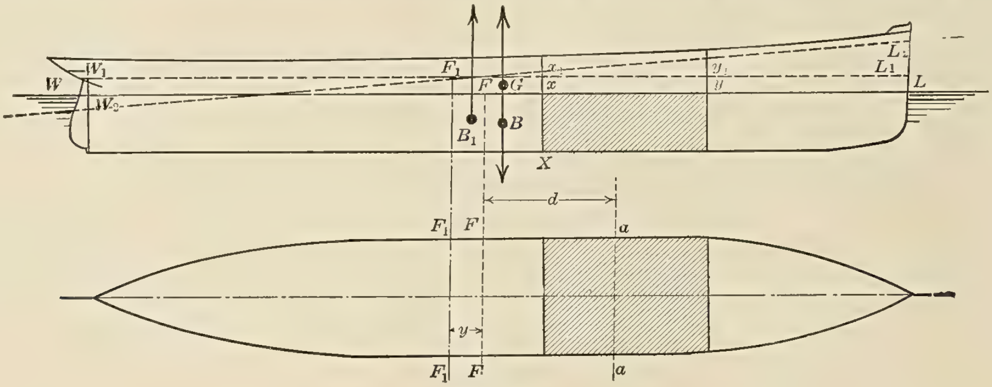


Fig. 13

The height of the new center of buoyancy, B_1, for the damaged condition is now found, and this distance, measured above the base, being added to the $B_1\ M$, gives the height of M above base. If we now deduct from this the height of the center of gravity above the base, we will then obtain the value of $G\ M_2$ in the damaged condition, and we can therefore use this to obtain the corresponding $M.\ C.\ T.\ 1''$. From this we can then ascertain the amount of trim as previously mentioned, care being taken to distribute the amount at each end in accordance with the position of the center of flotation of the damaged waterplane; for instance, if we assume the length of vessel as being 300 feet, and the new center of flotation at 100 feet forward of the after perpendicular, then 90 inches of trim would be distributed as follows:

$$90 \times \frac{100}{300} = 30 \text{ inches of trim aft,}$$

and

$$90 \times \frac{200}{300} = 60 \text{ inches of trim forward.}$$

It will be noticed that the bilging causes a reduction in longitudinal metacentric height, and this being used in the numerator of the formula giving $M.\ C.\ T.\ 1''$, thereby results in a small value for the latter being obtained, which has the further effect of increasing the amount of resultant trim.

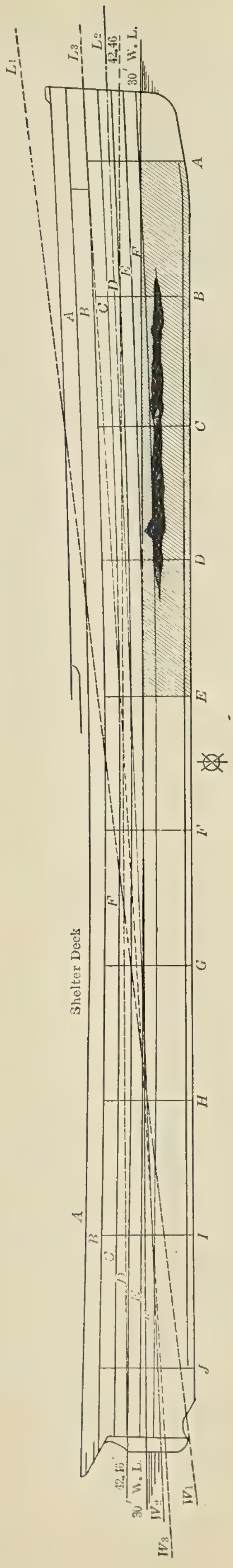


Fig. 14

Had the vessel been fitted with a watertight lower deck at a short distance above the waterline *W L*, so that the amount of flooding would have been limited in a vertical direction, there would have been, in addition to a restriction of the amount of lost buoyancy, a much less serious effect on the trim, owing to the inclusion of such a deck, enabling the original waterplane area to be retained, and in such a case the moment of inertia would have been preserved and a smaller amount of trim resulted, while on account of there being no great shift in the position of the center of flotation the smaller amount of trim would have been more evenly distributed at each end. The watertight deck is therefore seen to have great value from the point of view of trim also.

The following case, which is that of the vessel represented in Fig. 8, shows the effect on the trim due to flooding, resulting from bow damage, causing the loss of buoyancy in the forepeak and No. 1 hold. The dimensions of the vessel are 440 feet length between perpendiculars by 55 feet beam by 33 feet depth, plus shelter deck, the draft being 28 feet.

The amount of lost buoyancy after making allowance for the cargo contained in the space is 1,770 tons, and the area of the intact waterplane, also making allowance for the cargo, is 16,550 square feet. The amount of mean sinkage is therefore

$$\frac{1{,}770 \times 35}{16{,}550} = 3.75 \text{ feet.}$$

The total area of waterplane was originally 19,330 square feet and its center of gravity at amidships, and the lost amount of area is 2,780 square feet, having a center of gravity 161 feet forward of amidships.

The center of gravity of the new waterplane is therefore situated at

$$\frac{2{,}780 \times 161}{19{,}330 - 2{,}780} = 27 \text{ feet aft of 'midships;}$$

and this may be taken as also being the position of the center of buoyancy of the added layer.

The center of gravity of the lost buoyancy is 157 feet forward of 'midships. $157 + 27 = 184$ feet, which is the distance between the center of gravity of the lost buoyancy space and the center of the added layer of buoyancy. The trimming moment will be $1{,}770 \times 184 = 325{,}680$ foot-tons.

The *M. C. T.* 1" in the damaged condition is 851, and the total amount of trim is therefore $325{,}680 \div 851 = 382.7$ inches $= 31.9$ feet.

By taking into account the sinkage due to the lost buoyancy, and the distribution of trim in accordance with the position of the center of flotation, the new mean drafts are obtained as follows:

	Aft Feet	Forward Feet
Original drafts	28.00	28.00
Mean sinkage	+ 3.75	+ 3.75
Trim aft: $31.9 \times \frac{220 - 27}{440}$ (rise)	− 14.00	
Trim forward: $31.9 \times \frac{220 + 27}{440}$ (fall)		+ 17.90
New drafts in damaged condition:	17.75	49.65

The total depth of this vessel at the stem is 48 feet 8 inches, which shows the shelter deck at the fore end to be awash to the extent of 1 foot; but it must be remembered that although the loss of buoyancy was not arrested until the upper deck reached the water level, there will be an amount of reserve buoyancy preserved intact above this, provided the upper deck is perfectly watertight. This would reduce the amount of trim, but in any case the shelter deck would almost be

submerged, and so dangerously near to the water level as to make the vessel unseaworthy, while she would also be extremely difficult to navigate. The close proximity of the deck to the water level may result in damage to deck fittings, hatches, etc., by means of seas breaking aboard, and such damage would no doubt destroy the watertightness of the shelter deck at the fore end and result in the 'tween decks being flooded. Should this happen, the best possible condition that the vessel could be expected to float in would be that shown by Fig. 8, *i. e.*, with the fore end of the shelter deck submerged; but great danger would certainly exist owing to the existence of the water in the 'tween decks, and which may find its way into some of the other hold compartments or bunkers, etc., and thereby extend the flooding with increasing dangerous effect.

As a concluding example it will be interesting to take the most serious case of flooding resulting from a large vessel coming in contact with submerged ice or wreckage, with such force as to strip off and damage the shell plating on one side from the bow to a position so far aft as to lay open, say, four compartments, or 40 percent of the vessel's length to the sea, and to consider the effect on buoyancy and trim, together with the differences in effect by means of fitting (*a*) center line longitudinal bulkheads; (*b*) watertight lower deck. The vessel is represented by Fig. 14, her dimensions being as follows: 800 feet length between perpendiculars by 92 feet beam by 64 feet depth molded to shelter deck by 30 feet average working draft. Including the shell a displacement of 40,500 tons is given by a block coefficient of .64. The displacement contained in way of the bilged compartments, *i. e.*, between bulkheads *A* and *E*, is 17,020 tons, and the center of gravity of same is 167 feet forward of 'midships.

The total area of waterplane at 30 feet draft is 49,280 square feet, and the area of the lost portion is 20,820. The center of gravity of the lost portion is 169 feet forward of 'midships.

We must now make the allowances for buoyancy contained in the cargo, bunkers, structure, etc. Taking the amount of lost buoyancy as being 75 percent throughout the damaged compartment, then 17,020 × .75 = 12,765 tons actual amount lost. The net amount of waterplane area lost will be 20,820 × .75 = 15,615 square feet. The area of the remaining intact waterplane will therefore be 49,280 — 15,615 = 33,665 square feet. The amount of mean sinkage can now be found:

$$\frac{12{,}765 \times 35}{33{,}665} = 13.27 \text{ feet, depth of layer of sinkage.}$$

The intact waterplane area at half depth of this layer is 35,860 square feet, therefore the correct mean sinkage will be very near to

$$\frac{12{,}765 \times 35}{35{,}860} = 12.46 \text{ feet, corrected mean sinkage.}$$

30 + 12.46 = 42.46 feet mean draft in damaged condition. This mean waterline is shown dotted in Fig. 14.

We may now look into the question of trim, and in connection with this it may be as well to first of all find the *M. C. T.* 1" for the damaged condition, which will, of course, be a figure very much different to that for the normal condition. For this purpose we will deal with the waterplane at 42.46 feet draft, and assuming the vessel to be intact for the time being a "longitudinal metacenter" calculation gives the following results:

Waterplane area, 52,850 square feet.
Center of flotation aft of 'midships, 7.9 feet.
Longitudinal moment of inertia, 1,780,709,000.
Longitudinal *B M* (metacenter above buoyancy), 1,259 feet.

The portion of this new waterplane, in way of the damage, has a total area of 21,275 square feet, *i. e.*, 15,956 square feet lost and 5,319 square feet remaining, and a center of gravity 169.8 feet forward of 'midships.

The amount of lost area is found by calculation to represent an amount of longitudinal moment of inertia about its own axis, *i. e.*, I_a, equal to 110,522,500.

This, together with the further correction for $A\ d^2$, which is found to equal 503,000,000, gives the total amount of correction to be made to the longitudinal moment of inertia, as previously found for an intact waterplane at 42.46 feet draft, and having a center of flotation at 7.9 feet aft of 'midships.

Longitudinal moment of inertia of intact waterplane	1,780,709,000
Deduct ($I_a + A\ d^2$) = 110,522,500 + 503,000,000.	613,522,500
I^2 about center of flotation 7.9' aft 'midships =	1,167,186,500

A further correction is, however, yet necessary so as to obtain the moment of inertia of the damaged waterplane about its actual center of flotation, the latter being first of all found as follows:

Calculation for Determining the Actual Center of Flotation

Complete waterplane at 42.46 feet draft = 52,850 square feet with center of flotation 7.9 feet aft
Lost area = 15,956 square feet with center of flotation 169.8 feet forward

Area remaining = 36,894 square ft. distance between centers = 177.7 feet

$$\text{Then } \frac{15{,}956 \times 177.7}{36{,}894} = 76.9 \text{ feet shift of center of flotation further aft}$$

+ 7.9 feet aft of 'midships at present

The actual C. F. for the damaged condition is therefore 84.8 feet aft of 'midships

The distance from the actual center of flotation to the center of flotation about which the moment of inertia has been calculated is 76.9 feet, and as the area of intact waterplane is 36,894 square feet, the final correction is therefore

$$36{,}894 \times 76.9^2 = 218{,}000{,}000.$$

Then

1,167,186,500 = the *M. I.* about center of flotation at 7.9 feet aft of 'midships.
Less 218,000,000

949,186,500 = the corrected longitudinal moment of inertia of the damaged waterplane at 42.46 feet draft.

$$\text{Longitudinal } B\,M = \frac{I}{V} = \frac{949{,}186{,}500}{40{,}500 \times 35} = 669 \text{ feet } B.\,M.$$

Height of *B* above base	= 23.7
Longitudinal metacenter above base	692.7
Center of gravity above base	38.2
Longitudinal metacentric height in damaged condition	654.5

The *M. C. T.* 1" for the damaged condition can now be found as follows:

$$M.\ C.\ T.\ 1'' = \frac{W \times GM}{L \times 12} = \frac{40{,}500 \times 654.5}{800 \times 12} = 2{,}761 \text{ feet.}$$

The trimming moment can now be estimated, and this will be equal to to the moment of transference of buoyancy, *i. e.*, the amount of lost buoyancy multiplied by the distance from its center to the center of gravity of the added layer. We have already seen that the net amount of lost buoyancy is 12,765 tons, and that its center is 167 feet forward of 'midships. To obtain the position of the center of gravity of the added layer, we can safely take the position of the center of a waterplane at half depth of same or a mean between the position of the centers of the 30-foot normal waterplane and the 42.46-foot damaged waterplane. For the 42.46-foot waterplane we have just seen that this is situated at 84.8 feet aft of 'midships, while that for the 30-foot waterplane is given by the following:

$$\frac{15{,}615 \times 169}{33{,}665} = 78.5 \text{ feet aft of 'midships.}$$

The mean distance is therefore 81.65 feet aft of 'midships, which can be taken as the position of the center of buoyancy of the layer.

We therefore see that 12,765 tons of buoyancy have been transferred from 167 feet forward of 'midships to a position 81.65 feet aft of 'midships, a total shift of 248.65 feet.

The trimming moment is therefore $12{,}765 \times 248.65 = 3{,}173{,}000$ foot-tons, and this divided by the *M. C. T.* 1" gives the total amount of trim as follows: $3{,}173{,}000 \div 2{,}761 = 1{,}149$ inches of trim. This can now be distributed at either end in accordance with the position of the tipping center, *i. e.*, the center of flotation of the 42.46-foot waterplane, this being at 84.8 feet aft of 'midships.

$$\frac{1{,}151}{12} \times \frac{315.2}{800} = 37.9 \text{ feet, trim aft.}$$

$$\frac{1{,}151}{12} \times \frac{484.8}{800} = 58.1 \text{ feet, trim forward.}$$

These amounts of trim produce a waterline as shown by $W_1\ L_1$ in Fig. 14, where it will be seen to work out at a position very much higher than the extreme fore end of the vessel. Seeing that this metacentric method of calculation presumes the wedge of immersion to counterbalance the wedge of emersion, and that this does not obtain in the present instance, owing to the great difference between the vessel's deck and the new waterline at the fore end, it is obvious that even if the shelter 'tween decks had been taken as perfectly watertight, there could not have been a counterbalancing effect in the wedges, and that the vessel would eventually sink by the head after the lower holds had filled. The sinking would not be rapid at first owing to the time required for the inflow of water to pass from deck to deck, but after the immersion of the shelter deck occurred the sinking of the fore end would be greatly accelerated, as the wedge of immersion now adds very little as the change of trim continues. As has been previously seen a very serious stress effect may cause the vessel to break into two parts now that the buoyant support of the fore end is almost lost.

(*To be concluded.*)

MONTHLY SHIPBUILDING RETURNS.—The Bureau of Navigation reports 165 sailing, steam and unrigged vessels built in the United States during the month of June. Twelve of these vessels were steel steamships aggregating 26,191 gross tons.

Launch of the Battleship Nevada

The United States battleship *Nevada*, authorized by Congress in 1911, was launched July 11 at the yards of the Fore River Shipbuilding Corporation, Quincy, Mass., and christened by Miss Eleanor Ann Siebert, niece of Governor Oddie, of Nevada. The *Nevada* is a sister ship of the *Oklahoma*, which was launched by the New York Shipbuilding Company, Camden, N. J., March 23.

The *Nevada* is 583 feet long over all, 95 feet 2⅝ inches beam, and on a mean draft of 28 feet 6 inches displaces 27,500 tons. The vessel will be propelled by Curtis turbines of approximately 24,800 horsepower, actuating twin screws and supplied with steam by Yarrow type boilers burning oil fuel exclusively. The designed speed is 20.5 knots.

The main armament consists of ten 14-inch guns, firing a projectile weighing 1,400 pounds at a muzzle energy of about 66,000 foot-tons. The guns are placed in four turrets, two turrets having two guns each and the other two turrets three guns each.

The main armor belt, which extends 400 feet along each side of the vessel, is 13½ inches thick and 17½ feet wide, extending from 9 feet above to 8½ feet below the water when the vessel is loaded to her mean draft. The three gun turrets are protected by 18-inch armor on the face and 9 and 10-inch armor on the sides, while the roofs are 5 inches thick. The face of the two gun turrets is 16 inches thick and the barbettes are protected by 13-inch armor.

Excellent protection against plunging fire and also against fragments of shells which might be exploded in passing through the ship's plating in wake of the gun deck, is provided by two protective decks, the lower one being 1½ inches thick on the flat and 2 inches on the slope, and the gun deck, which is the upper protective deck, 3 inches thick.

AMERICAN SHIPBUILDING FOR THE YEAR ENDED JUNE 30, 1914.—During the fiscal year ended June 30, 1914, there were built in the United States 1,291 vessels of 311,578 gross tons, compared with 1,648 vessels of 382,304 gross tons for the same period of 1913. One hundred and four steel steamships, aggregating 189,818 gross tons, were built during the year ended June 30, 1914, as compared with 121 steel steamships aggregating 225,467 gross tons built in the previous year. In 1914 66 percent of the steel steamship tonnage was built on the Atlantic coast, 7 percent on the Pacific coast, and 27 percent on the Great Lakes, while in 1913 62 percent of the steel steamship tonnage was built on the Atlantic coast, 7 percent on the Pacific coast, 30 percent on the Great Lakes and 1 percent on the Western rivers. The principal vessels built during the last fiscal year are four American-Hawaiian Company steamships, each of 6,600 gross tons, and three Grace Company steamships, each of 6,300 gross tons, all for the Panama Canal trade, and averaging 4,000 net tons. The steamship *Matsonia*, for the Hawaiian trade, 9,728 gross tons, is the largest vessel built in the United States since 1905, and the *John D. Archbold*, 8,374 gross tons, is the largest oil tanker yet built in the United States. On the Great Lakes ten steamers of over 1,000 tons each were built, the *Alton C. Dustin*, 7,978 gross tons, being the largest. Only three large schooners were built. In all, 38 vessels of over 1,000 tons each were built aggregating 169,000 tons.

LLOYD'S SHIPBUILDING RETURNS.—According to Lloyd's returns, which take into account only vessels of 100 tons and upwards, the construction of which has actually begun, there were, excluding warships, 477 vessels of 1,722,124 tons gross under construction in the United Kingdom at the close of the quarter ended June 30. The tonnage now under construction in the United Kingdom is about 169,000 tons less than that which was in hand at the end of last quarter, and over 281,000 tons less than that building in June a year ago.

Questions and Answers for Marine Engineers

Inquiries of General Interest from Readers Regarding Marine Engineering and Shipbuilding Will be Answered in This Department

CONDUCTED BY H. A. EVERETT*

Q.—I would like an expression of opinion regarding the inclosed cards (Fig. 1), showing what defects are indicated and how they should be remedied and also the horsepower of each card. The go-ahead and back-up eccentrics on this engine are cast in one piece, and are keyed on the shaft, so it would be impossible to move them to correct any error. The cut-off is a notched quadrant on the reverse engine, which gives each cylinder the same cut-off. The cylinder diameters are 24, 38 and 61 inches; the stroke, 3½ feet. The piston rods are 5 inches in diameter. The high-pressure cylinder is located forward and has an indirect piston valve. This exhausts directly into the intermediate-pressure steam chest; the intermediate-pressure valve is a slide valve; there is also a slide valve on the low-pressure cylinder. All have direct valve motion of the Stephenson link type. The eccentrics are keyed on couplings which are located between each engine. The cranks are set at 120 degrees. M. M. P.

A.—The tabulation for indicated horsepower follows:

Cyl.	End.	A. Sq. In.	Lth.	Spring.	M.E.P.	A. Piston.	I. H. P.	I. H. P. Per Cyl.	
H. P.	Top	3.24	4.80	80	54.0	415.5	183		
H. P.	Bot.	3.14	4.72	80	53.2	395.9*	172	355	
I. P.	Top.	1.98	3.92	40	20.2	1075.2	177		
I. P.	Bot.	1.99	3.89	40	20.5	1055.6*	177	354	=1071 Total.
L. P.	Top	3.58	4.87	10	7.35	3019.	181		
L. P.	Bot.	3.57	4.82	10	7.4	3000.*	181	362	

*Assuming P. Rod = 5″ Dia.

The distribution of power is excellent and the cards show no serious defects except for the high-pressure cylinder. In this

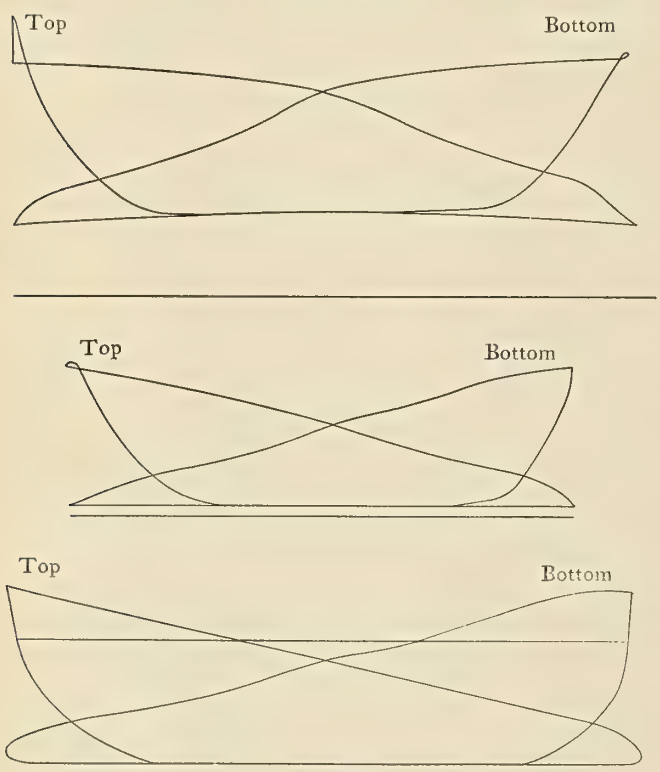


Fig. 1.—Indicator Cards Shown at Reduced Scale

the compression occurs too early on both top and bottom cards, indicating too long exhaust laps of the high-pressure valve and slightly too much angular advance. The exhaust lap for the top end should be shortened and the angular advance slightly reduced. This latter could be done by making an offset key for the eccentric. The intermediate cards could be improved a bit by lengthening the valve stem, which would retard compression for the top card and accelerate compression for the bottom card. (The valve gear may have sagged.) The curve in the back-pressure line of the high-pressure cards indicates a small first receiver, a restricted flow through the exhaust ports. This latter would be helped by the change already suggested for the high-pressure value. The whole engine is linked up rather more than customary, but the distribution of power is so good it is doubtful if opening it out would improve matters much.

Q.—Please explain the difference between real and apparent slip and show how each may be calculated. F. P. A.

A.—The face of a propeller blade is in reality a portion of a screw thread of a certain pitch. Imagine that this thread could be given a certain number of turns in a fixed steel nut having the same thread. It is evident that it would advance a distance equal to the pitch times the number of turns. When working in water, however, the same number of turns would *not* cause the screw thread to advance the same distance, for the reason that the water does not act like the fixed nut. The pressure of the screw upon the water forces some of the water out of the way, thus allowing the screw to slip back a certain amount for each turn. For a given time, then, a propeller working without any slip would travel a distance equal to its pitch times the number of revolutions it has made. As a matter of fact, since the propeller is attached to a ship, it has apparently traveled the same distance that the ship has in that time. The difference between these two distances in a given time is called the *apparent slip*. A propeller having a pitch of 15 feet and making 100 revolutions per minute would advance 1,500 feet per minute without slip. If the speed of the ship is 12 knots, she would travel $12 \times 6080/60 = 1{,}215$ feet per minute. The apparent slip is therefore $1{,}500 - 1{,}215 = 285$ feet per minute, or $285/1500 = 0.19$, or 19 percent.

The real or true slip of the propeller is somewhat different from the apparent slip, in that the passage of the ship through the water causes some of the water astern of the ship to follow the ship. This current of water is called the *wake*, and its speed is dependent upon the shape of the afterbody of the ship. Since this current is moving in the same direction as the ship, the distance that the propeller advances through this moving water in a given time will be less than if the water were still. The slip through this moving water, or wake, is called the *real or true slip*, and is obviously greater than the apparent slip. Suppose that the wake had a speed of 10 percent of that of the ship,* or 122 feet per minute. The propeller would then advance through the wake at a speed of $1{,}215 - 122 = 1{,}093$ feet per minute, and the real slip would be $1{,}500 - 1{,}093 = 407$ feet per minute, or $407/1500 = .27$, or 27 percent.

The relation between real and apparent slip may be expressed as follows:

$$1 - S_r = (1 - S_a)\ (1 - W)$$

Where S_r = real slip,

S_a = apparent slip,

W = wake. For the case above noted,

$$1 - S_r = (1 - .19)\ (1 - .10) = .81 \times .9 = .729.$$

Therefore $S_r = .27$.

* Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

* The wake can be quantitatively determined for a given slip only by model-tank experiments. It generally ranges from 10 percent to 20 percent.

Q.—What is the best type of fuel oil burner for marine work?
B. O.

A.—There are three types of burners for oil fuel, the classification being made with regard to the method used in atomizing the oil. These three methods are atomization by steam, air or mechanical means.

The steam atomizing burners use 4 or 5 percent of the steam generated by the boilers and, therefore, are not suited for marine use on account of the fresh water required to make this amount of steam.

Air atomization requires large, heavy air compressors to give air under sufficient pressure for atomization. This method requires considerable steam to run the air compressors and also the compressors take up much room and need special attendance.

Mechanical atomization is accomplished by having the oil in the burner under high temperature and pressure. The shape of the nozzle and the internal fittings of the burner are important factors in the atomization. Oil pumps are used to give the required pressure (200 pounds per square inch) and these can be attended by the regular fireroom force.

Mechanical atomization is, therefore, the only practicable method for use with marine boilers at present, and is the only method used at sea by ships of the United States Navy. Then the draft is on the closed stoke-hold principle and the amount of air supplied to the burners is regulated by means of air-cones. In some cases the slots in these cones are made adjustable, in others they are fixed, and the air supply regulated by changing the speed of the fireroom blowers. In the latter type the strips forming the slots are twisted to form guide vanes so as to give a rotary motion to the air. The ends of the burners are fitted with radial slots or tapered screw threads to give a whirling motion to the oil spray, which then enters the furnace in the shape of a cone.

There are five types of mechanical atomization burners at present in use in the United States Navy, viz., Normand, Thornycroft, Schutte-Koerting, Peabody and Fore River.

Q.—Will you kindly trace for me the losses in the power line of a steam-engine-driven ship from the indicated horsepower to the power which is actually used for propulsion, say the power required to tow her from a tow-line?
W.

A.—Indicated horsepower is the power developed in the cylinders of the engines, and as only a portion of this power is finally used in driving the ship, it is important to know wherein the losses occur.

First, the engine itself absorbs a certain amount of power on account of friction of the moving parts. This friction is classed under two heads; viz., "initial friction," due to tightness of pistons, stuffing-boxes, bearings, etc., and "load friction," due to the load upon the bearings, thrust block, etc. The power required to drive the pumps attached to the main engines is classed with initial friction. The amount of power required to overcome these losses varies considerably. The initial friction in large well-adjusted engines with independent pumps is about 3 or 4 percent of the indicated horsepower, whereas 10 percent is required for poorly-adjusted engines having pumps attached. Not much is known about the power absorbed by load friction, but it is generally estimated to be about 7 percent of the remainder obtained by subtracting the initial friction from the indicated horsepower. For a reasonable approximation we can say that friction causes a loss of 10 percent in first-class reciprocating engines having independent pumps, whereas a loss of 15 percent is to be expected in engines having pumps attached. Thus, for reciprocating engines the horsepower actually delivered to the propeller is about 85 to 90 percent of the original indicated horsepower. For turbine engines the horsepower delivered to the propeller is measured directly by a torsion meter placed well astern of the thrust block, the small amount of friction in the bearings aft of this being neglected.

Of the power that reaches the propeller a portion is wasted by the losses of the propeller. The remainder is the power delivered by the propeller to the thrust block. [There is a small amount of power obtained from the wake which is also delivered to the thrust block.] Of the power delivered to the thrust block, a portion is used to overcome the increase in the resistance of the ship due to the suction of the propeller on the hull, and the remainder is the "effective horsepower" or the net horsepower used to drive the ship; this latter corresponds to the power determined by model experiments. The summation of these losses shows that about 40 to 50 percent of the indicated horsepower is lost, so that the effective horsepower is about 50 to 60 percent of the indicated horsepower. This relation $\frac{\text{effective horsepower}}{\text{indicated horsepower}}$ is called the efficiency of propulsion.

Q.—What is the best way to install the internal feed pipes inside a Scotch boiler? Should the feed enter the top or bottom of the boiler? What direction should the water be discharged from the feed pipe to get the best results?
H. F.

A.—In general, the feed valves cannot be placed on that part of the boiler best suited to receive the feed water, so that internal feed pipes are necessary to lead the water to a place where there is a down current of water, in order that the comparatively cool feed water does not interfere with the natural circulation. It is customary to fit two feed valves, one for the main feed pump and one for the auxiliary, the valve for the latter ordinarily being on the left side of the boiler. These valves are of the stop-check type and are placed about on a level with the furnaces. The internal feed pipes should be of brass, and lead upward from the valves between the corrugations of the furnace and along the shell of the boiler to a point somewhat above the level of the tubes, but still below the lowest working level of the water. From here they are led back into the boiler about two-thirds of the length, and then should be turned downward somewhat in front of the combustion chamber. This length of pipe also provides a means for further heating the feed water. Care should be taken that steam cannot enter the internal pipes, as the sudden condensation of the steam by the cool feed water produces shocks which may damage the piping. The internal pipes should not touch the shell except where they connect with the external fittings.

It is not a good plan to discharge the feed water at the bottom of the boiler, as the water spaces under the furnaces do not receive sufficient heat to provide good circulation there, and the entrance of cool feed water would retard this rather than assist it.

In some cases the feed water has been introduced into the steam space in the form of spray, but while this plan has some advantages. it has not met with general favor. It cannot be used in boilers liable to prime, and also may cause the steam pressure to fall when the feed is turned on or increased.

New Bombay Dredger.—The Bombay Port Trust, through their consulting engineers and agents, Messrs. Sir J. Wolfe, Barry & Partners Company, recently placed an order with Messrs. William Simons & Company, Ltd., Renfrew, for a powerful bucket hopper dredger, similar to the *U. S. Corozal*, built by the same company for the Panama Canal. The new dredge will be used for deepening the Suez Canal at the Port of Bombay and the approaches thereto.

Unveiling of Memorial to Titanic Engineers.—The ceremony of unveiling at Southampton the memorial to the engineers of the *Titanic* was performed April 23 by Sir Archibald Denny before a large assemblage. The address was delivered by Albert W. Swalm, United States Consul at Southampton.

Letters from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

An Air Pump Breakdown

Several years ago, when the writer was serving as assistant engineer on a large coastwise vessel, the main engine, which was a condensing triple with independent air pump, suddenly slowed down. An investigation showed that nothing was wrong with the engine or the boilers, so that the natural conclusion was that something was wrong with the exhaust, as the vacuum was suddenly lost in the condenser.

Upon investigation it was found that the trouble was in the air pump, so the engine was stopped and the pump quickly taken down. It was found that the pump rod had broken at

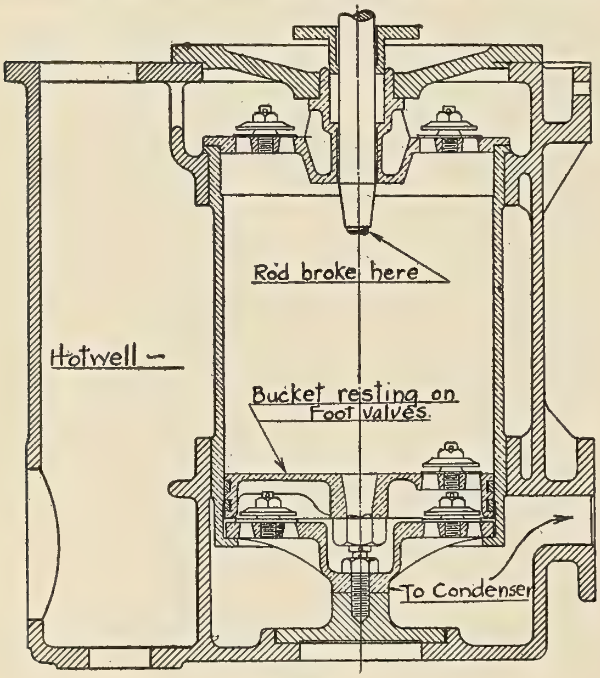


Fig. 1

the end of the threaded part, causing the bucket to drop off and rest on the foot valves, as shown in Fig. 1. The bucket and rod were then removed. The nut, which had dropped off with the broken piece of the rod still in it, was also taken out and the cover plate replaced. The gland in the cover plate was then plugged with a soft wood plug, which swelled up and filled the gland nicely, so that it did not leak. The circulating pump was a force pump and could not be used to suck through the hotwell. It was, therefore, cut out and the auxiliary pumps thrown in so that they drew direct from the hotwell. This only meant the turning on and off of valves, so therefore did not require much time, and the engine was soon started up and worked fairly well with such a temporary arrangement.

However, the trip was a long one and the rod had to be repaired, otherwise there would be a decided loss of speed and economy. Fortunately the vessel was equipped with a fairly good machine shop, so that the repair could be done carefully.

The end of the rod was faced off down to the bottom of the taper. It was then drilled and tapped to take a 1¾-inch standard bolt. A counterbore was then made about ½ inch deep, with a diameter equal to the diameter of the bolt (1¾ inches). A steel stud was then made to fit this, as shown in Fig. 2. This was made with a ¾-inch shank having the same diameter as the counterbore, so that the one would fit the other very tightly. The end that fitted into the rod was made fairly long for strength and rigidity, while the other end was made the same as the original and threaded to take the nut that had been on the rod.

By making the shank fit tightly into the counterbore and making it ¼ inch longer than the counterbore a material amount of strength was gained, not only in gripping, but in general rigidity. The broken piece was easily removed from the nut and the bucket and rod replaced while the engine was again stopped.

With the bucket and rod again in working order the engine

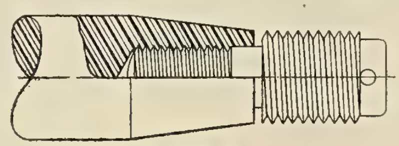


Fig. 2

was started and continued to run as well as it had previous to the breakdown. Naturally, upon reaching port, a new plunger rod was procured, but it was unnecessary to install it at the time. The repaired rod was not taken out and replaced by a new one until the engine was thoroughly overhauled several years later. The piece was found to be in excellent condition and could easily have continued in service for some time.

STUD.

Let Well Enough Alone

From what little experience I have had in the engineering line, it seems to me that a large amount of trouble is caused by continually accepting substitutes for standard goods of known and tried values. This is probably so at the present time as much as at any other, and it is believed that the ability of selling agents will keep it so for years to come. It is only through the general appreciation of the value of a standard article, by both engineers and owners, that much of this trouble can be eliminated.

There are two sides to every question, and in such a question as the adoption of a new brand of material there are two distinct points to be considered in determining whether or not a change in the article in use is justified. One point is concerned with the material, the other with the personal side of the matter.

In regard to the material side, it is only logical to suppose, unless prices are known to be exorbitant, that one is getting good value from the manufacturers, and in such a case it is not very logical to suppose that one is going to get much better values from some other manufacturer. This does not always apply. Perhaps an attempt is being made to introduce a new article of merit. Such an article may be sold at a very low price in order to introduce it, but when once established it must be soon sold at a price that will offer a fair profit to the makers, so such a gain will usually be only temporary. In such a case one may have made a small monetary gain if the material has been satisfactory. Considering that the material may not be satisfactory, and may be almost a total loss, the best that may be said is that such a change, from a monetary point of view, is little more than a gamble.

It is also well to remember, in regard to material, that the average job on board ship is small, and does not represent a very large investment in material. Take, for instance, the

renewal of packing in a valve stem or in a steam pipe flanged joint. A difference of value of 5 or 10 cents ($0/2\frac{1}{2}$ or $0/5$) in the packing used for the job seems quite immaterial when the value of the labor and the possibility of delays due to blow-outs, etc., are considered; yet it is just such cases as this that usually cause trouble, for when that additional 5 cents ($0/2\frac{1}{2}$) is multiplied by the total number of gaskets that can be cut from the whole sheet of packing, it makes the extra cost of the whole sheet seem much too large. The result is that sometimes an inferior brand is purchased and that a blow-out causes more expense from damage and delay than a year's supply of the high-grade packing would have cost.

I am quite convinced that the personal side of the question is just as important as the material side. The average man aboard ship cannot be expected to take kindly to the idea of discarding what he knows to be good from experience in order to adopt something that he knows nothing about. The man aboard ship is desirous of making a job that will hold; he does not want to be obliged to renew it again in a few days.

It is this natural tendency that makes a known good material go much farther than an unknown material of equal merit. Among many cases I recall one in which the engineer's force had been using a packing called T—— with the very best of results. This packing was expensive, and it was therefore decided to substitute another that was much cheaper and that gave equally good results on test. The results were not what might have been anticipated. The cheaper packing cost more in the end than the T—— originally used, and this purely because of the personal side of the question. The new brand was not used with such economy; since the men did not have faith in it it was always being renewed, where the old and tried packing would not be renewed, and in the end the greatly increased consumption alone made the total cost of packing smaller for the high-grade packing.

In the use of oil, I recall one case in which a sea trip had been habitually made on 40 gallons of oil. Each oiler knew just what this particular brand of oil would do and placed great faith in it. This oil was made by a trust, and was believed to be entirely too expensive, so another oil, said to be equally as good, was taken on board. This last oil was not made by a trust, and was not so expensive for that reason, according to theory. The result was that it required 70 gallons of the new oil to do the same work that was done by 40 gallons of the old oil. The next result was a return to the trust-made oil and also to the consumption of 40 gallons per trip. Of course, more experience with the cheaper oil would have materially lessened the amount needed, but it is questionable whether its total cost would ever have geen as low as that of the higher-priced product then in use. Substitution would have therefore been a very poor policy on account of the increased bulk if for nothing else.

The number of these cases could be increased almost indefinitely, but these two fully illustrate the points mentioned; in the first the personnel was probably responsible for the lack of economy; in the second the fault was in the material itself. In neither case was there anything gained by the change.

I do not think of advocating the use of high-priced material when equally good results may be obtained for less money, nor do I intend to discourage experimentation with new materials, but I do desire to impress upon the engineer that the old motto, "Let well enough alone," has its application to marine engineering as well as elsewhere, and that changes should be made with care and with due consideration of everything involved.

The claims of agents and of advertising matter are, in many cases, so much greater than the material can possibly fulfill that they should be regarded with great suspicion. A standard line of goods, thoroughly tried out, giving good satisfaction, and enjoying the confidence of the personnel of the engineer's department, is not to be lightly discarded even for the saving of a few dollars per year. It will sometimes pay to refer the claims of the agent selling new goods to the manufacturers of the standard line now in use for their comments. The manufacturers will be pleased to comment, and may perhaps give some very good advice in the matter.

W. W. B.

A New Method for Obtaining "Offsets"

The writer was called upon to make the necessary preparations for an inclining experiment on a certain vessel the interior arrangements of which had been materially changed at various times after the vessel was launched. Information regarding the vessel's displacement at varying drafts was not available, nor were any of the necessary curves which are used in these and similar ship calculations. Even the body plan was missing, therefore offsets for the body plan had to be obtained, and this work had to be done as quickly as possible, because the ship was then in dry dock and such work can only be done while the ship is in dry dock.

The usual method of obtaining these offsets is shown at the left in Fig. 1. A plumb line is first suspended at the centerline of the ship to see if the ship is absolutely vertical in the

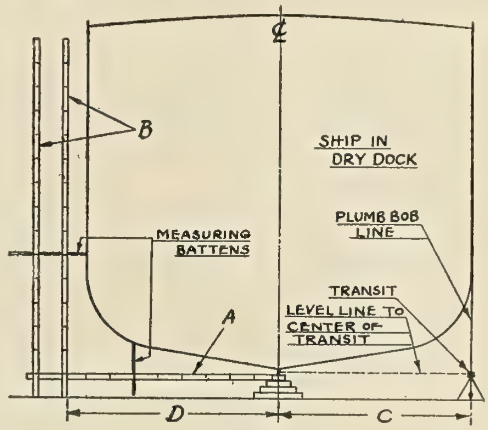


Fig. 1

dock. If not, the amount of deviation from the vertical in a certain distance is noted, and this is used in setting up the batten *A* at right angles to the vertical centerline of the vessel.

For simplicity we shall assume that the ship is vertical, then batten *A* is fixed in a perfectly horizontal position at the bottom of the keel. This batten is marked off about every two feet and the divisions numbered. The zero mark should coincide with the centerline, *i. e.*, the center of the keel. Just beyond the extreme half-breadth two vertical battens *B* are erected. These battens are divided in the same manner as batten *A*, and their zero marks should coincide with the edge of *A*. It is evident then that with the aid of measuring battens the offsets can be obtained, referred to the vertical and horizontal battens as shown, for various sections of the vessel, and from these a body plan can be drawn and faired in.

This method requires all battens to be carefully divided, the battens *A* and *B* by marks 2 feet apart and the measuring battens by eighth-inch intervals, as on a common scale measuring inches and eighths.

For the case in question, however, such battens and means for holding them in their respective positions, etc., were not directly available, so that the following method was adopted to obtain the offsets:

Various stations were located for convenience at the edges of deck houses, etc., and by squaring across to the rail two plumb lines were dropped from the same point. One of these was just long enough to reach the flooring of the dock from any point of the rail, while the other was long enough to

girth the largest section of the vessel from the rail to the keel. The string that was to girth the section was then drawn in and fastened to the turn of the garboard strake, or upper edge of the keel, by drawing it down behind a heavy iron bar, the upper end of which held the string in close contact with the hull.

From the plumb line any convenient base line was laid off parallel to the ship's keel on the flooring of the dock. The base line was usually from 30 to 40 feet long, depending on obstructions. At the other end of the base line an engineer's transit was set up, so that its horiizontal axis would come in the same horizontal plane with some point on the keel. This point was found for each section, so that all the sections could be referred to a common base line.

To find the point, the "gun" was swung around and used as a level, while an assistant marked the keel in the line of sight.

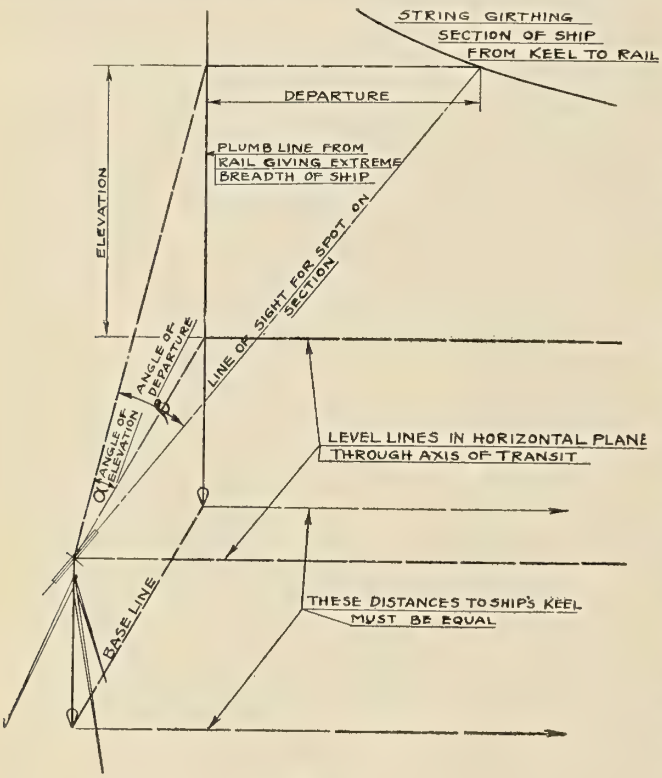


Fig. 2

The "gun" was then swung back and lined up with the plumb line, and held while the horizontal scale was turned until its zero reading coincided with the zero of the vernier. This made it easier to handle the readings in the office, as they all read from zero at each section.

It only remained to take an elevation and a departure, each in degrees, for enough spots on each section to be able to lay the spots off on the drawing and run a fair section through them. We were always careful to take the edge of the keel where the string crossed it as one spot, so that we could determine the half breadth of each section, knowing the thickness of the keel.

A fairly good idea of what was done is represented in Fig. 2. This is a sketch showing the necessary lines and distances in perspective, *i. e.*, as it would look to a person on the scaffolding about one-third the way up the ship's side.

The readings were kept systematically, so as to facilitate the work in the office, where the triangles were solved to get the actual elevation and departure in feet, inches and eighths of an inch instead of degrees, minutes and seconds. The elevation is equal to the base line length multiplied by the tangent of α, Fig. 2. The departure is equal to the base line multiplied by tangent β/ cosine α. When these are calculated and tabulated for each section it becomes a simple matter to change them all to a common base line and lay out each section.

The sections can be located longitudinally from the deck plan, as previously stated. In this way the full sheer draft may be drawn and faired by waterlines, buttocks and diagonals. Then equidistant sections may be laid out and a new body plan drawn showing these. This should be done at a large enough scale to admit of accurate calculations.

In using such offsets it will be seen that they are taken to the outside of the outside strakes throughout. Allowance can be made for this so that the sections will all be drawn half the thickness of the shell plating inside of this, giving a displacement, etc., from the body plan so constructed that will be exact.

Of course, in using this system difficulties will be encountered if some sections have double curvature. In that case either avoid them and trust to fairing or use a little ingenuity in attaching the string. "Transit."

An Emergency Pump Rod

On one occasion the writer had the experience of repairing a bilge pump on a large yacht. While on a rather extended cruise the bilge pump rod broke beyond repair, and it became necessary to do something, as the pump was needed continually. In looking for a solution to the difficulty it was noticed that the vertical columns on the independent feed pump were of the same diameter as the rod of the bilge pump. The feed pump was therefore dismantled sufficiently to take out one of the columns, which was then turned up and fitted in the bilge pump. Very little machining had to be done on it, since it was of the same diameter as the original rod. It was necessary, however, to replace the column in the feed pump to prevent further and more complicated difficulties.

This was done by using a couple of pieces of live oak of the same length as the distance between the shoulders on the column. These were clamped together with a steel rod between them, which had been cut just the same length over all as the original column. The rod was threaded on the ends and nuts were made for it.

It is readily seen that when this was set up as a column the live oak struts were sufficient for compressive stresses, while the rod held them in place and took care of all the tensile stresses brought to bear on the cylinders.

This arrangement not only proved to be a good temporary repair, but both the oak struts and the rod have been in service for over a year. Of course, new parts have been procured to be ready for any emergency, but the incident shows what good, substantial repair work can sometimes be done in case of emergencies, especially at sea. Incidents like this are not only interesting but instructive when related, and should be a great help to those who may at some time be up against the same or a similar proposition. Live Oak.

The Bolinders Company-New York.—The Bolinders Company-New York, with offices at 30 Church street, New York City, has been formed to manufacture and sell in the United States the two-cycle, valveless, direct-reversible, crude oil engines of the type developed by J. & C. G. Bolinders Mek. Verkstads A. B., Stockholm, Sweden. These engines are built in sizes ranging from 5 to 320 horsepower, and up to the present time over 10,000 of them have been placed in service.

The Naval Appropriation Bill.—The total naval appropriation bill, as passed by the Sixty-third Congress for the coming year, amounts to $140,350,833.61 (£28,800,000). The programme for new construction for the coming year includes two battleships, six destroyers and eight or more submarines, while the recent sale of battleships *Idaho* and *Mississippi* to the navy of Greece makes available an additional fund for the construction of a third first-class battleship.

Marine Articles in the Engineering Press

Problems in Naval Architecture.—In a series of three lectures on modern ships, just concluded at the Royal Institution by Sir John Biles, the main problems in naval architecture were grouped under three general headings: Smooth water sailing, ocean travel and the war navy. Under the first head the problems of buoyancy, stability, strength and resistance of ships were discussed from the viewpoint of the naval architect. The discussion of propulsion, which included both steam and sailing ships, covered the relations of effective propulsion to machinery design and the methods of investigating resistance, power and propeller efficiency. The second lecture, devoted to ocean travel, discussed the problems of speed, comfort and safety, subdivision and the attendant calculations for stability. The third lecture, dealing with the war navy, showed clearly that the same problems of stability, strength and subdivision apply to warships as well as to other ships, except that provision has to be made for a greater extent of flooding in the warship. 5,250 words.—*Engineering,* March.

Development of Internal-Combustion Engines for Marine Purposes.—By M. Peloux. This paper describes the improvements in the type of Diesel engines manufactured by Messrs. Schneider & Company for marine purposes. In general, the improvements enumerated relate to the starting and maneuvering gear, the exhaust, air-inlet, starting and fuel valves and the fuel pumps, air compressors and means for lubrication. The starting and maneuvering gear is arranged with a view to starting and reversing the engine as easily and as quickly as possible. One complete revolution of the driving shaft suffices to start the engine. This is done by hand, through a reducing gear or by a Servo motor. Valves in the cylinder heads are provided with special devices to prevent their falling into the cylinders if their rods break. The fuel valves are either direct-acting straight needles or are balanced and work by rotation. The fuel valve casing of the cylinder is fitted at the bottom with a ball pulverizer and a multiple hole diffuser. Each oil pump is regulated by varying the amount of lift of its suction valve. 13 illustrations.—*The Institution of Mechanical Engineers,* June.

The 32-000-Ton Floating Dry Dock at the Portsmouth Dockyard.—The new floating dry dock at the Portsmouth dockyard, designed to take the largest and heaviest naval vessels in service, was built by Messrs. Cammell, Laird & Company, Ltd., Birkenhead, to the designs of Messrs. Clark & Standfield. The dock is of the "box" type, and consists of a pontoon or lifting portion and two parallel side walls built on to and forming part of the pontoon. When floating at its moorings in sea water the dock is capable of lifting and carrying a vessel of 32,000 tons displacement with drafts up to 36 feet, the weight of the shores and berthing gear being taken as part of the weight of the ship. The dock is 680 feet long over all and 144 feet wide. The clear width between the rubbing timbers at the top deck is 107 feet 6 inches. The side walls are 65½ feet high on the outside and rise 46½ feet above the pontoon. The depth of the pontoon is about 20 feet. Each of the side walls has a watertight deck running the whole length, and the bottom pontoon is divided both longitudinally and transversely by a number of watertight bulkheads. These bulkheads and decks divide the pontoon and walls into about 80 watertight compartments. The displacement of the dock up to within 6 inches of the pontoon deck at the center is 47,400 tons. The total weight of the dock, including 3 inches of water in the pontoon, is 15,400 tons, and thus the net lifting capacity is 32,000 tons, giving 207 tons per inch immersion in way of the pontoon. The minimum metacentric height of 5 feet 6 inches occurs when the water is about 4 feet above the top pontoon. This increases to 47 feet 6 inches when the pontoon deck rises from the water. The pumping installation consists of eight Babcock & Wilcox watertube boilers, together with eight sets of centrifugal pumps of the vertical spindle type, each set being driven by a compound condensing engine. The boilers are placed two at each corner of the dock with the pumping engine rooms separated from the boiler rooms by watertight bulkheads. The electrical equipment consists of four direct-coupled generators, each having an output of 900 amperes and 225 volts. A Westinghouse motor generator is fitted in each wall, having an output of 1,000 amperes, for the purpose of supplying current to a ship in the dock. Workshops are arranged in the starboard wall of the dock. 12 illustrations. 2,000 words.—*Engineering,* May 1.

The Motor Tank Ship Elbruz.—A description of a motor-driven oil tanker, built to the order of the Société Anonyme d'Armement d'Industrie et de Commerce, of Antwerp, by the Tyne Iron Shipbuilding Company, Ltd., of Willington Quay-on-Tyne, the propelling machinery being supplied by the Nederlandsche Fabrick van Wertuigen en Spoorwegmaterieel, of Amsterdam. The vessel is 390 feet long over all, 51 feet 2½ inches extreme beam, 29 feet molded depth, and at a draft of 23 feet displaces 9400 tons. The hull is constructed with transverse framing, with the side stringers continuous in way of the transverse bulkheads. The machinery, which is placed aft, consists of two reversible single-acting six-cylinder Werkspoor engines, with cylinders 22 inches diameter and 39⅜ inches stroke, working on the four-stroke cycle and driving twin screws. The engines develop a total of 2,200 brake horsepower when running at 125 revolutions per minute. The auxiliary machinery is steam driven, two cylindrical multitubular donkey boilers being installed, one in the engine room and the other on the deck above. Both boilers are arranged for burning liquid fuel on the Meyer-Smith system, while the lower boiler is also arranged for heating by the exhaust gases. 9 illustrations. 1 plate. 900 words—*The Shipbuilder,* June.

High-Degree Feed-Water Preheating on Steamers.—By Ofterdinger. The author presents a new method of preheating boiler feed-water on steamers by using the exhaust steam from auxiliary engines and receiver steam to a temperature of 284 degrees F. and higher. The advantage of such high preheating of feed-water lies, first, in the improvement of the efficiency of the engine plant, and, second, in the beneficial action on the life of the boiler, which is in this way spared from the heavy stresses consequent upon the injection of comparatively cold water. In addition, the higher the temperature of the water the freer it is from air, which is objectionable when present in the boiler. For such high preheating two-stage preheaters in series are used, working on steam of different pressures. When used in connection with triple or quadruple expansion engines the feed-water may first be heated by the exhaust steam from the auxiliary engines with an addition of steam from the low-pressure receiver. From this preheater the water passes into the second element, where it is heated by the steam from the intermediate pressure receiver, the pressure of the steam in the second element being maintained at a higher level than in the first preheater. Data are given from tests showing the results of feed-water preheating in one and two stages. The saving in heat by using the two-stage preheater arrangement as compared with the single-stage arrangement amounted to 3.5 percent. 2 illustrations.—*Zeitschrift des Vereines Deutscher Ingenieure,* April 18.

Recent Japanese Warships.—By Rear Admiral Constructor Motoki Kondo. A paper read before the Japanese Institution of Naval Architects at Kobe. The remarkable development of the Japanese navy during the last ten years is shown by the completion of six battleships, five battle cruisers, five second-class cruisers, seven gun boats and thirty-nine destroyers, not to mention torpedo boats, submarines and other vessels of smaller size. The main particulars of the types of vessels added to the Japanese navy during the last ten years are enumerated and it is pointed out that, together with the development of the navy, the facilities for naval construction in Japan have likewise been steadily improved. The mild steel used in Japanese warships is now almost entirely supplied by the steel works at Kiushiu and, in addition, a number of ship fittings, auxiliary machinery, etc., are now obtainable from Japanese manufacturers. 22 illustrations. 3,000 words.—*Engineering,* March 27.

The Motor Ship Arum.—This article includes a detailed description of the engines and machinery arrangement of the motor ship *Arum,* a twin-screw general-cargo ship built by Swan, Hunter and Wigham Richardson, Limited, for Sir Marcus Samuel, for the Persian Gulf trade. She is 360 feet overall, 47 feet beam and 27 feet molded depth, and will carry about 5,000 tons deadweight at about 10½ knots. The engines are of the four-cylinder Polar Diesel type built by the same firm. Each set of engines has four cylinders of 16.15 inches diameter by 33,9 inches stroke, and gives 675 brake horsepower at 123 revolutions per minute. The fuel valve rocker-arm is the only moving part visible in the valve mechanism, except, of course, the camshaft. A light cast iron casing is fitted over the shaft, the only opening being a narrow slot for the rocker to work in. The lower part of this forms a trough in which an oil bath submerges the rollers and leads to a very quiet valve gear. The method of driving the valve gear is rather unique and is composed of a pair of "coupling rods," from eccentrics carried on a disk on the forward coupling of the crankshaft. Another feature of the design, and an important one, is the method of supporting cylinders, leaving the lower part of the engine considerably open, since there is no forced lubrication. The exhaust is led into big water-jacketed pipes, and at the end of the engine room can either be passed up the funnel or under the donkey boiler. All the auxiliaries are steam-driven and they include an auxiliary air compressor, electric lighting engine, turning engine, and pumps. 6 illustrations. 2,200 words.—*The Engineer,* May 29.

Development of High Power Marine Diesel Engines.—By James Richardson, B. Sc., Assoc. M. Inst. C. E. The progress of the marine Diesel engine, although remarkable thus far, is temporarily at a standstill, awaiting the application of the experience gained during the first phase of its evolution. There are several causes for such a condition and probably the most important are: Over-ambition in increasing the sizes of units, using land engines in the marine field without making necessary modifications, and the lack of experimental and research work. The advantages of the Diesel engine in the marine field are well known, but there is some debate as to the relative merits of the two general types, the two- and four-stroke cycle. In considering future possibilities Mr. Richardson treats only of the two-stroke cycle, and throughout the discussion he deals systematically with each part, its functions and possible improvements. In Diesel engines the speed of revolution is relatively higher than that of the steam engine, and this is allowable because of the necessary accuracy of workmanship and the excellence of material required by the parts subject to pressure and temperature. The piston speed brings up the question of inertia, which, if high enough, permits of easier lubrication and varies the direction of pressure on the main bearings. The stroke-bore ratio depends on the ratio of combustion volume to cooling surface, method of scavenging limits in height of engine and the type of crankshaft adopted. Mean effective pressures average about 65 pounds per square inch on a brake horsepower basis for normal running. Various means by which this mean effective pressure in the future may be augmented are given and methods of accomplishing same proposed. An investigation of the loads on engine parts, particularly on crosshead guides and columns, of an oil engine and a steam engine, both of the same power, etc., shows some marked differences and forms a very good basis for design in comparing with steam engine practice. Very many types of engine framing are used and all prove more or less efficient. Crankshafts and crank-webs involve thorough investigation, and at best so many variables are brought into formulas that a certain amount of experience is necessary in designing these parts. The question of cylinders and cylinder-heads is probably the most varied one in the entire design. Assuming that the material used throughout is excellent, as it should be, the arrangement and design of the cylinder and cylinder-heads, with their various valves and ports, determine to a large degree the efficiency of the engine as a whole in its cycle of operations, power developed and fuel economy. Cast iron is almost universally adopted for the cylinder-heads and liners, cast steel having proved unsuccessful for such purposes. In two-cycle engines, whether Diesel or of the ordinary internal combustion type, scavenging is an advantage and means a gain of power. In the Diesel two-cycle type scavenging is necessary and a scavenging air pump is fitted to supply air at from four to eight pounds per square inch to clean the cylinder of the products of combustion. For large engines of the future the methods of using two valves or two ports will prove the best. Two and three stage compressors are used for purposes of starting, reversing, etc., and supply air at pressures from 300 to 1,000 pounds per square inch. As to fuel injection, since the combustion in two-cycle engines takes place so rapidly, the timing of injection must be very accurate and regulation for slow running is difficult. The design of valve gears should not present difficulties to the engineer, because something definite is required and variation of temperature and pressure does not materially affect these parts. Starting by compressed air is the practice almost universally adopted, and for this purpose it must be kept on hand or arranged for by auxiliaries. 49 illustrations. 10,000 words.—*Engineering,* April 24 and May 1.

The Berlin-Stettin Canal.—A new German waterway, officially termed the "waterway for large ships, Berlin-Stettin," an extension of the one already existing, has just been opened. This canal, one of the many large and costly canal constructions lately carried out by Germany, forms a new waterway between the capital and the most important sea-port of Prussia. Much difficulty was experienced not only in various stages of construction, but at the very outset arguments were advanced as to the better of two routes. While all this discussion was going on it became urgent to start the construction, as the existing Finow Canal proved less and less capable of handling the rapidly increasing traffic. The new canal or waterway has a length of about sixty-two miles. Loading places and private wharves have also been constructed at the expense of municipalities and other bodies. Quays have also been built, especially where Crown lands adjoin and where the sides of the canal have been puddled. The towing on the canal will be done by means of steam tugs, and it is to be compulsory for all vessels not self-propelled which traverse the canal. 5 illustrations. 3,000 words.—*Engineering,* May 8.

Boiler Manufacturers' Convention. — The American Boiler Manufacturers' Association will hold its twenty-sixth annual convention at the Waldorf-Astoria Hotel, New York City, Sept. 1 to 4.

New Books for the Marine Engineer's Library

Standard Metric Equivalent Tables. Size, 12½ by 10 inches. London, W. C., 1913: The Central Translations Institute. Price, 1/2.

These tables comprise weights and measures, also prices in francs and marks, the latter being based on figures from the Board of Trade for the rates of exchange. The tables, which are neatly printed on a large card, should prove very useful to those who need accurate and authoritative values for conversion.

Tide and Speed Tables for 1914. Size, 2¾ by 4 inches. Pages, 248. London, 1914: Alfred Graham & Company.

Published in handy pocketbook form, this volume gives not only tide tables for the principal seaports of the United Kingdom, port charges, knot tables, distance tables, electrical terms, etc., but also includes some handy engineers' tables, giving the dimensions of chain cables, sizes of tanks and the weights of wrought iron plates, angles and round bars, and also a table for the calculation of the consumption of coal per day based upon indicated horsepower per hour.

Percentage Compass for Navigators, Surveyors and Travelers. By John C. Ferguson, M. Inst C. E. Size, 36 by 23 inches. London, E. C., 1913: Longmans, Green & Company. Price, unmounted, 2/6 net; mounted on linen, 3/6 net.

Ferguson's percentage unit of angular measurements, a system of measurement that reduces problems in plane trigonometry to simple arithmetic, has been practically applied to a compass dial to form what is known as a percentage compass. There is no doubt that the practical application of this system to any engineering computations involving angular measurements, etc., will effect a tremendous saving of work and a decided simplification of all calculations in plane trigonometry.

Great Lakes Red Book, 1914. Size, 3 by 4¾ inches. Pages, 147. Cleveland, Ohio, 1914: Penton Publishing Company. Price, $1.00.

This book contains a list of over 1,000 vessels on the Great Lakes, with the name of owner, captain and engineer of each vessel. The list is arranged according to the fleets to which the vessels belong, each fleet has a separate number, and preceding the list is an index in which the names of the vessels are arranged alphabetically, with the number of the fleet following the name of the vessel. There is also a list of ore carriers, arranged alphabetically, giving the capacity of the vessels in gross tons on about 19 feet draft, and a vessel supply directory, giving a list of fueling ports, engineers' supply houses, ship chandlers, proctors in admiralty, grocers, butchers and others who furnish supplies or make repairs to vessels at different ports on the Great Lakes.

Andrew Thomson's Yachting Guide and Tide Tables, 1914. By Andrew Thomson, A. M. I. N. A. Size, 3¼ by 4½ inches. Pages, 184. 41 Pall Mall, London, S. W., 1914: Andrew Thomson. Price, 1s.

Beginning with general tide tables giving the times of high water at London Bridge and at various places in England and Wales and along the coasts of Scotland, Ireland, France, Holland, Belgium, Germany, Spain and Portugal, the author goes on to give tables of English equivalents for metric weights and measures and tables of comparison of English and foreign money values. Following this are several pages of general items relating to stowage measurements, signals for pilots, admiralty warrants, registration of yachts and regulations for preventing collisions at sea. Carefully compiled tables show the distances from English ports to foreign ports, and also time differences between Greenwich and the most important ports of the world. The principal tables in the book, however, relate to rates of speed, time allowances and racing rules of the Yacht Racing Association. There are also lists of cup winners and detailed instructions for the measurement of yachts as drawn up by the Permanent Committee of Berlin, 1906. Although this is a small volume, it contains much valuable information for yachtsmen, most of which is arranged in convenient form for ready reference.

Wannan's Marine Engineer's Guide. Fifth edition, in two parts. By A. C. Wannan, C. E., and D. Lindsay. Size, 5½ by 8 inches. Pages, Parts I and II, each 280. Numerous illustrations. London, 1913: Crosby, Lockwood and Son. Price, 6/- net, each.

Part I deals with only the subject of arithmetic and contains a great number of questions from marine engineers, with simple, clear and correct solutions to the same. Notes on beams, boilers and mechanical powers are also included, together with the latest Board of Trade regulations. Part II contains 310 elementary questions with illustrated answers, and verbal questions and answers, together with a set of thirty-seven completed drawings. Indicator diagrams are discussed in detail and each drawing where necessary includes a note giving the particular points and the requisite formulæ for the various parts. Both books are very complete and should prove a most valuable collection of data and information for marine engineers.

The Dock and Harbor Engineer's Reference Book. By Brysson Cunningham, B. E. Size, 4 by 6½ inches. Pages, 320. Illustrations, 144. Plates, 6. Philadelphia, 1914: J. B. Lippincott Company. London, 1914: Charles Griffin & Company, Ltd. Price, $3.00 net.

REVIEWED BY H. McL. HARDING*

As Mr. Cunningham's book is about the only one of its kind printed in English it is of special interest and value. It is a condensed compilation from such accepted authorities as the Proceedings of the International Navigation Congress, the minutes of the British Institute of Civil Engineers and various technical journals. It also contains many quotations from previous books by the same author.

The method of references is extremely satisfactory, as it enables the engineer to consult readily the original sources of information. As far as is possible the costs of construction of the port works are reduced to a unit basis, such as acreage or lineal foot lengths, with reasons for variations from these unit prices clearly explained. The equipment necessary for carrying out harbor construction and the costs of the apparatus are given in detail.

The general plan of the book is comprised under the following headings: Port Administration, Nautical Data, Methods of Construction and Costs of Harbors, Docks, Wharves, Locks, Graving and Floating Docks, Dredging and Maritime Canals and Coast Protection. There are also descriptions of the engineering work of most of the important seaports, including the often neglected fishery and minor harbor plans.

Excellent judgment has been shown by the author in selecting the data which would be the more valuable for marine engineers, and the book should be on the desk of every harbor engineer, not only as a book of reference, but also as a book of instruction.

* Consulting Engineer, Marine Terminals, New York.

Rivers and Estuaries or Streams and Tides. By W. Henry Hunter, M. Inst. C. E., M. Am. Soc. C. E. Size, 5½ by 9¼ inches. Pages, 68. Illustrations, 8. London and New York, 1913: Longmans, Green & Company. Price, 2/6 net.

The elementary study given in this book is, to a large extent, based on lectures delivered to the students of the Institute of Civil Engineers in various parts of Great Britain, and upon further lectures on streams and tides delivered to the engineering students in the University of Manchester. The object of these lectures was to furnish the young students information, and to offer them counsel, which experience had taught the lecturer would have been of lifelong service to him had he known these facts when he himself was a student. The subjects discussed include river improvement works and estuarial works, giving both European and American examples.

Mexican Fuel Oil. Size, 6¼ by 8¾ inches. Pages, 150. Numerous illustrations. London, E. C., 1914: Anglo-Mexican Petroleum Products Company, Ltd. Price, 3/6 net.

While the book is intended primarily to give a comprehensive account of the production, refining, distribution and uses of Mexican oil as produced by the Mexican Eagle Oil Company, it includes a very general discussion on the advantages of oil for fuel and its many and varied uses. Starting with a review of the progress of petroleum, the general advantages of fuel oil and the types of burners and systems used, descriptions are given of special applications of fuel oil in the navy, the mercantile marine, on railroads and for stationary steam plants. All through this discussion prominence is given to the subject of coal versus oil fuel, the data given showing some very startling advantages for fuel oil in practically every one of its many applications.

Arithmetic of the Steam Boiler. By Charles J. Mason. Size, 5 by 7 inches. Pages, 225. Illustrations, 21. New York, 1914: McGraw-Hill Book Company, Inc. Price, $1 net. London, E. C., 1914: Price, 4/2 net.

This book is a compilation of arithmetical rules and formulas applicable to steam boilers of various types. The author claims no originality in the preparation of the material, excepting only the arrangement and manner of presentation. It is intended as a book of reference for those who may require rules and formulas directly related to steam boilers, and its aim is concentration and logical order in the arrangement and treatment of the various features introduced. It is not intended to teach the elements and principles of arithmetic in this book, as might be inferred from its title, but only the application of arithmetic to steam boiler calculations. It is presumed that those who may use it already understand arithmetic but desire to have a compact set of rules and formulas conveniently ready for use, without having to look through several books for a certain formula when required. Those who are preparing for examination for engineer's certificates and licenses will find the work of great assistance to them.

Handbook for Machine Designers and Draftsmen. By Frederick A. Halsey, B. M. E. Size, 8½ by 11 inches. Pages, 494. Numerous illustrations. New York and London, 1913: McGraw-Hill Book Company. Price, $5.00 net.

After over thirty years of active association with machine design and construction, fifteen of which were spent in designing machinery for one of the leading manufacturers of the United States and eighteen as editor of the *American Machinist,* Mr. Halsey has brought together in convenient form for desk use the essential data and basic facts which designers, draftsmen, superintendents, engineers and machinists need constantly in the work of designing all kinds of machinery and machine parts. The book is in no sense a treatise on machine design or applied mechanics. It is a collection of material carefully digested, classified and indexed, presented in such form as to give as clearly as possible all of the facts which designers, draftsmen and others need in all classes of machine design.

The contents of the book may be classified, roughly, in three parts: First, the data in common use, available by itself but essential to work of this character; second, the best of the contributions to the technical press and proceedings of technical societies which are not easily accessible, and, third, the contributions of specialists who have given freely of their data to make this work as broadly useful as possible. A better idea, however, of the broad scope and remarkable completeness of the book can be gained from the list of subjects discussed. The first half of the book includes chapters on mechanical principles of design, plain or sliding bearings, ball and roller bearings, shafts and keys, belts and pulleys, flywheels, cone pulleys and back gears, spur gears, bevel gears, friction gears, worm gears, helical gears, planetary gears, ropes, chains, brakes, friction clutches, cams, springs, bolts, nuts and screws, wire and metal gages, hydraulics and hydraulic machinery, pipe and pipe joints, minor machine parts, press and running fits and balancing machine parts. Following this are notes on miscellaneous mechanisms and the performance and power requirements of tools, and then several chapters are devoted to the materials commonly used in machine construction, taking up in turn cast iron, steel and the various alloys. A separate chapter is devoted to the construction and proportions of steam boilers, while there are similar chapters on the steam engine, the gas engine and compressed air. Finally there are chapters on mechanics and the strength of machine parts and over fifty pages of useful tables.

To present such an enormous mass of useful data in suitable form for immediate reference within the limits of a book of this size, and still treat each subject adequately, is a task of no small magnitude, and the author has shown excellent judgment in the form of presentation as well as in the skilfull use of illustrations, charts, diagrams and tables. The size of page, style of type and form of charts and tabulated matter all aid in making a well balanced, useful reference book for machine designers.

Novel Dry Dock for Torpedo Boats.—The dock construction firm von Klitzing, of Hamburg, Germany, has received a contract from the German navy for the construction of a novel type of dry dock for torpedo boats. The dock will consist of a lifting section and several floating pontoons. When docking a torpedo boat a pontoon will be sunk within the dock to receive the boat, and then both the dock and pontoon will be pumped out together. The suction valves of the pontoon will then be closed and the dock sunk sufficiently to enable the pontoon to be floated out with the torpedo boat on its deck. A second pontoon can then be placed in the dock and another boat docked in the same manner. The advantage of this arrangement over the ordinary floating dry dock is the possibility of docking any number of torpedo boats at the same time by using additional pontoons. As the pontoons carrying torpedo boats can be easily transported, and as they have a very shallow draft, they can be brought close to the shore, thus facilitating quick repairs on the craft that are being docked.

Panama Pacific Line.—The International Mercantile Marine Company, comprising the American, Atlantic Transport, Red Star, White Star and White Star-Dominion lines, has announced that early in 1915 a new passenger and freight service, to be known as the Panama Pacific Line, will be established, with sailings every three weeks, between New York and San Francisco through the Panama Canal. The steamers selected for this route are the *Finland* and *Kroonland,* each of 22,000 tons displacement, formerly employed in Red Star Line's New York-Dover-Antwerp service.

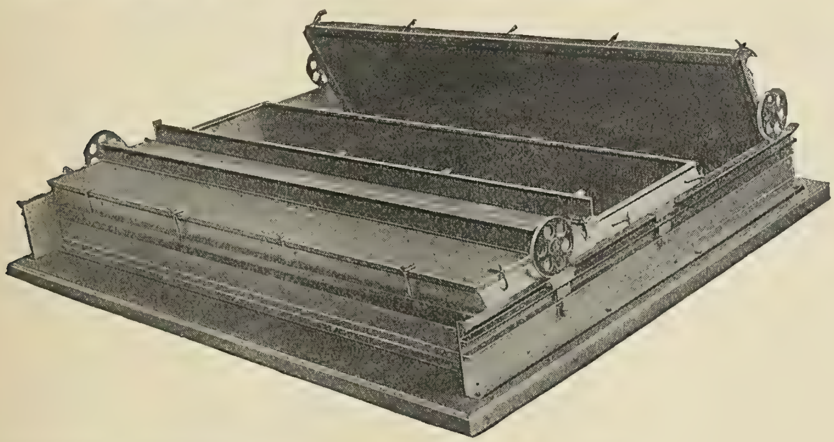
ENGINEERING SPECIALTIES

Underwriter Pivot-Balance Hatch Cover

Captain Arthur N. McGray, of 119 West Seventy-first street, New York City, an active steamship master of wide experience, has invented an improved type of steel hatch cover which he is now arranging to place on the market.

Steel covers, hinged to the coamings, which can be removed only by means of heavy tackle, uplifting them into a vertical position, have long been in effective use; but the disadvantage of always requiring steam power to handle them, and the first cost and upkeep of the equipment necessary to their safe handling, have militated to their universal adoption. Besides, in ships engaged in dry-cargo trades, particularly in climates where frequent heavy and passing showers are encountered, any type of cover that demands more than a few minutes of time, the expenditure of any considerable power, or experienced care in handling, is looked upon with disfavor. In the new pivot-balance type of cover illustrated, it is claimed that all these objectionable features have been minimized or altogether eliminated.

Structurally, all its elements are designed to standard dimension products of the rolling mills, thereby reducing the



problem of construction to merely punching and riveting. Channel or bulb-iron "stiffeners" are riveted to the upper side of the cover-plate, around the under edge of which runs a deep channel bar (into which the water-tightening material is fixed), which fits closely over the half-round of the coamings, so that not only do the toggle bolts draw the cover plate down watertight, but the channel bar acts as an efficient stiffener to the side and end coamings. Thus, the entire space enclosed by the coamings is free and clear of all obstruction for cargo stowing purposes. Along the sides of the coamings, fore and aft, runs a light trackway of steel. Midway of the fore-and-aft length of each cover-section there is fitted to its upper side an ordinary axle, carrying a small wheel, which rests upon the trackway mentioned. When any cover-section is at its normal position the wheel rests on a "filler-piece" which is cut out of the trackway. This filler-piece is supported on a jack-screw block which is coarse threaded, to move the cover up or down very quickly. Thus, the cover sections are lifted off the coamings and trundled into the space provided for them, where they may be pivoted into a vertical or semi-vertical position, all depending upon the manner in which the deck plan of the ship has been designed for their accommodation.

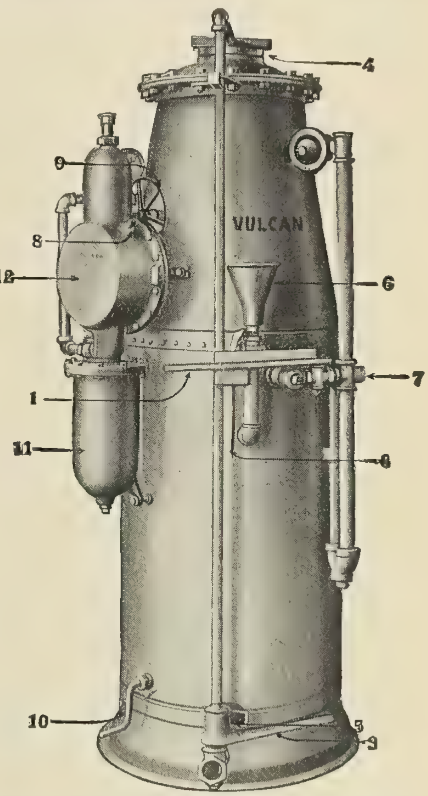
To replace a cover-section, pivot-balance it into nearly a horizontal position (one man at each side) and trundle it back until its wheels rest upon their own particular filler-pieces; then lower away the ratchet screw till the weight of the cover rests upon the coamings; throw up the toggle bolts into the forks on the cover and set up their butterfly nuts. When this is done, the battening down is completed.

Where a plurality of cover sections are required, as in the case of extremely large hatchways, the sections may be loosely coupled together by iron bars and all run off in one operation. In the Great Lakes' type of bulk carrier it is estimated that six men could put on and batten down, ready for any kind of weather, 32 hatches in a half hour, or take them off in 20 minutes.

Complete and simple provision has also been made to accommodate the principles of this design to all classes of craft—form barges and canal boats to "tramp" or ocean liners.

A Unique Acetylene Generator

An acetylene generator that employs a new and ingenious principle to meet the very exacting demands of an autogenous welding outfit is being marketed by the Vulcan Process Company, of Minneapolis, Minn., and Cincinnati, O. In this ma-



chine the feed mechanism drops an automatically measured quantity of 1¼ by ⅜-inch carbide into the water, varying the quantity to suit the demands made on the gas supply, producing a clean, cool gas at unvarying pressure. The motor that drives this automatic feed utilizes the buoyancy of the gas passing from the generator to the torch; thus the feed is increased as the gas consumption increases, or lessened when the gas consumption lessens, or the feed is automatically stopped and started when the torch is turned off or on. If the pressure for any reason should tend to rise above normal, the gas is conducted through a by-pass, rendering the feed inoperative until sufficient gas is used to lower the pressure. Possible accidents due to puncture are eliminated, it is claimed, by locating the feed motor in the pipe between the generator and the torch, and using the passing gas as motive power, instead of following the usual method of utilizing the gas pressure in the machine.

Being designed to use 1¼ by ⅜-inch carbide, it is claimed the machine will deliver 15 percent more acetylene than if the same quantity of screenings of carbide were used, and better gas results from the carbide falling deep into the water before complete decomposition ensues, securing cooler genera-

tion than is possible with screenings, which have a tendency to decompose near the surface, causing generation under high temperature and failure to give the gas the benefit of rising through a considerable volume of water, whereby it is washed and cooled. The carbide chamber and feed mechanism are removable, thus opening the machine for complete inspection. The entire generator is protected against careless manipulation by a locking device, which prevents removing the cap for refilling or opening any valves without following a definite safe routine.

Efficiency of Welded Joints as Applied to the Manufacture of Warehouse Trucks

A striking example of the increased efficiency and generally decreased cost of manufacture by welding sheet metal articles compared with drilling and riveting is shown on the steel trucks made by the Standard Motor Truck Company, of Chicago.

These warehouse trucks were formerly made by drilling and riveting all of the joints. Welding by the Oxweld process

was proposed and a test truck made by this method. The results were so conclusively in favor of this construction that it was immediately adopted and the riveting process abandoned.

Welding not only produced a one-piece truck in which the welded joints proved far stronger than the riveted joints formerly used, but it has increased the output per man about 20 percent with a saving of over 30 percent of the previous cost of manufacture per truck.

Tests of both the welded and riveted joints used in the manufacture of these trucks were made by the Bureau of Inspection, Tests and Construction of Robert W. Hunt & Company, engineers, Chicago. Three specimens were tested; the first consisted of a stringer tube and a cross tube welded together by the Oxweld process. Under a maximum load of 25,460 pounds the cross tube broke from the stringer tube at the weld. The second specimen consisted of a cross tube riveted to a stringer tube by two ¼-inch rivets in double shear, one in the stringer and one in the cross tube through a plug and bushing inserted in the cross tube. Under a maximum load of 4,740 pounds the rivet in the stringer tube sheared off. The third specimen consisted of a cross tube joined to a stringer tube by a ¼-inch rivet in double shear in the cross tube and a ¼-inch riveted reduction of a plug inserted through the stringer tube, the head of the plug being in tension. Under a maximum load of 5,800 pounds the rivet in the cross tube sheared off and the riveted connection in the stringer tube pulled partially through the stringer tube.

Personal

Harry Wissner has been appointed assistant to Mr. Miller on the steamer *Olcott.*

Nelson A. Cartier has been engaged as chief engineer on the steamer *H. A. Bagster,* of Norfolk, Va.

Captain O. G. Haines has been appointed local inspector of steam vessels at Boston to succeed J. F. Blaine, resigned.

Captain William McCann and Engineer Alfred Pardee were recently placed in charge of the tug *W. B. McCullough,* Albany, N. Y.

Thomas E. Beasley has accepted the position of assistant sales manager of the American Engine & Electric Company, Bound Brook, N. J.

Dudley S. Johnson succeeds the late Sam Mayer as manager of the Chicago branch of the Joseph Dixon Crucible Company, Jersey City, N. J.

Merrill Mardon has been appointed to fill the position of chief engineer of the steamer *Angler* of the Potomac River, in place of B. O'Donnell, resigned.

Robert Burke has been appointed chief engineer of the steamer *Alice M. Gill* of the Homegardener Sand Company. Mr. Burke will be assisted by Henry Burkley.

William Tibby, formerly chief engineer of the steamer *A. E. Shores, Jr.,* has been appointed chief engineer of the steamer *Protection* of the Henderson Sand Company.

Daniel Grieves has been appointed to succeed John Hilton as chief engineer of the steamer *C. H. Little,* owned by the United Fuel and Supply Company, of Detroit, Michigan.

William Evans is chief engineer and Captain A. E. Bailey commander of the steamer *Austraiana,* owned by the Furness Company. Her home port is West Hartlepool, England.

H. E. Blom, assistant inspector of hulls at Baltimore, has been transferred to San Juan, P. R., as local inspector, to succeed W. K. Martin, who has been transferred to Boston.

H. W. Keith has recently been promoted from the grade of instructor to the grade of assistant professor in naval architecture at the Massachusetts Institute of Technology, Boston, Mass.

William Gardiner, formerly of the New England Navigation Company, has been engaged as chief engineer on the steamer *Isis* of the Bridgeport Towing Company, Bridgeport, Conn.

John R. La Foe, who was engineer on the steamer *John H. Hogan,* has accepted the position of chief engineer on the steamer *City Point* of the Seal-Ship Company, New Haven, Conn.

Prof. I. B. Abell has been appointed professor of naval architecture at the Liverpool University, succeeding his brother, Prof. W. S. Abell, who is now chief surveyor to Lloyd's Register of Shipping.

John Seeman, formerly chief engineer of the steamer *Albert Y. Gowen,* has been appointed chief engineer of the new steel

steamer *Kelley's Island* of the Kelley's Island Lime and Transport Company.

Captain James Wood is in charge and Albert Hayck is chief engineer of the small side-wheel passenger vessel *Victor* of the Albany and Troy Steamboat Company, which went into commission July 5.

Captain Charles Pickett was transferred from the tug *Mabel* to the tug *R. G. Davis*, and Lemuel Herrington was transferred to the same tug from the *George M. Southwick*, to act as chief engineer.

Captain George E. Cooley was at the wheel and Elsworth B. Mealy had charge of the engines of the tug *Charles C. Wing*, while the vessel made its trial trip on July 18 last, after having been partly rebuilt.

John J. Hughes has been appointed to succeed David A. Black, resigned, as chief engineer of the steamer *City of Toledo* of the White Star Line, plying between Detroit and and Port Huron, Michigan.

Carl Becker, formerly chief engineer of the steamer *Edward Recor* of the Kelley's Island Lime and Transport Company, has been appointed chief engineer of the steamer *Alva S. Chisholm* of the same company.

August Schenk, formerly chief engineer of the steamer *Alice M. Gill* of the Homegardener Sand Company, has accepted the position of chief engineer of the steamer *Edward Recor* of the Kelley's Island Lime and Transport Company.

Captain James H. Dolan, who was formerly superintendent on barge canal work, is now in charge of the twin-screw passenger steamer *Julia Safford*, which went into commission on July 5 last. John J. Kenny is chief engineer of the *Julia Safford*.

Edward Conklin, of Rondout, has been chief engineer of the New York towing steamer *William H. Bavier* since it was built. This vessel recently arrived at Albany commanded by Captain Herbert Du Mont, of Rensselaer, with two oil tanks for the Texas Oil Company.

Louis Miller, formerly chief engineer of the steamer *Alva S. Chisholm* of the Kelly's Island Lime and Transport Company, has accepted the position of chief engineer of the steamer *Olcott*, which has been chartered to ply between Oswego, N. Y., and the Thousand Islands.

Frederick O. Ball resigned his position as general manager of the American Engine and Electric Company, of Bound Brook, N. J., on July 1, to engage in the manufacture and sale of carburetors with his father, Frank H. Ball, under the firm name of Ball & Ball, Detroit, Mich.

Captain Edward Scott is in command and Henry Matte chief engineer, with Archie Winkler first assistant, on the towing steamer *Empire* of the Albany Towing Company. The *Empire* has been chartered by the Great Lakes Dredging & Dock Company for work on the Hudson River.

Harry J. Marks, manager of the New York office of the American Engine & Electric Company, Bound Brook, N. J., has been promoted to the position of sales manager of the company. Mr. Marks is a member of the American Society of Mechanical Engineers and other engineering societies.

John Sherratt, general superintendent of the White Star Line at Genoa, is about to retire after thirty-two years of active service, and has been presented with a silver salver by his employers. Mr. Sherratt has very ably acted in the capacity of general superintendent since he was appointed in 1904.

J. W. Hamilton, director of Messrs. William Hamilton & Company, Ltd., shipbuilders, Port-Glasgow, was elected president of the Shipbuilding Employers' Federation at its annual meeting held recently in Edinburgh. Mr. Hamilton succeeds Mr. Herbert B. Rowell, shipbuilding director of Messrs. R. & W. Hawthorn, Leslie & Company, Ltd., Hebburn.

Hugh M. Macmillan has been appointed manager of the shipbuilding department of the Fairfield Shipbuilding & Engineering Company, Ltd., of Govan, Glasgow, with a seat on the board of directors. Mr. Macmillan succeeds Mr. Alexander W. Sampson, who has resigned after fourteen years' service as manager of the Govan firm. The new manager was formerly general manager of the shipbuilding yards of Messrs. Workman, Clark & Company, Ltd., of Belfast.

Obituary

Charles F. Magoun died on July 5 last. Mr. Magoun was treasurer of the Hyde Windlass Company, of Bath, Maine.

Joseph G. Robertson died recently from acute pneumonia at his home, 6 Claremont road, Forest Gate. He was the eldest son of Mr. A. W. Robertson, of Messrs. A. W. Robertson & Company, of the Lea Shipbuilding Yard, Canning Town.

Engineer Rear-Admiral Wishart died recently in his sixty-second year. In the many important posts that he occupied in His Majesty's navy, his personal characteristics and administrative qualities won for him the respect and admiration of all those with whom he came in contact.

Charles Henry Libbey, president of the Graphite Lubricating Company of New Jersey, died recently at Bound Brook, N. J., ager 62. Mr. Libby was for thirty years connected with the H. B. Claflin Company, New York, and resigned to accept the presidency of the Graphite Lubricating Company twelve years ago.

Matthew Clover, a well-known shipbuilder, recently of the firm of Messrs. Clover, Clayton & Company, of Birkenhead, died at his residence at Willaston, Cheshire, in his sixty-seventh year. Mr. Clover had been active in shipbuilding until he resigned about three years ago from the firm with which he had been associated for forty-seven years.

Francis James Trewent, recently of the firm of J. F. Trewent and Proctor, Ltd., died on May 17 last at his residence at Hampstead as a result of heart seizure. As an engineer Mr. Trewent was well known, not only to naval architects, but also to a large number of people interested in the mercantile marine. At the age of sixteen he entered the Royal School of Naval Architecture, at South Kensington, where he had the companionship of fellow students who later attained the highest distinction in that branch of engineering. Mr. Trewent was a member of the Institution of Civil Engineers, and other technical societies.

Alexander Dunbar, who had been appointed chief engineer of the new Cunard liner *Aquitania*, died suddenly on April 4 at Whiteinch, Glasgow, from a severe attack of pneumonia. He had not completely recovered when, anxious to be out during the completion of the *Aquitania*, he resumed his overseeing duties on that vessel. Mr. Dunbar had been in the the Cunard service since May, 1883, and previous to his appointment to the *Aquitania* he was chief engineer on the *Lusitania* from February, 1911, and took her on her maiden voyage under the direction of Mr. John Currie, consulting engineer to the Cunard Line, under whom Mr. Dunbar had also served on the *Mauretania*.

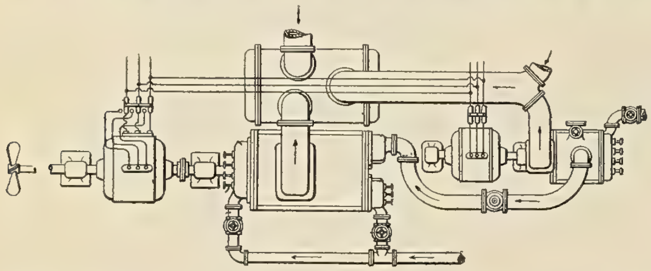
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,095,461. SHIP PROPULSION. WILLIAM L. R. EMMET, OF SCHENECTADY, N. Y., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

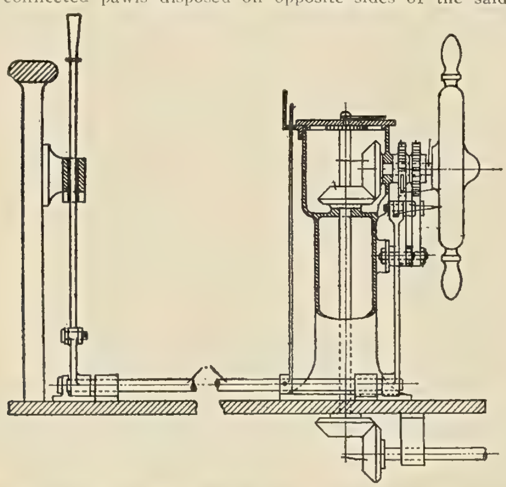
Claim 18.—In a system of ship propulsion, the combination of a turbine constructed and arranged to operate condensing and non-condensing, means for cutting a portion of the turbine buckets out of service for non-condensing operation, an electric generator driven by the turbine, a propeller and its shaft, an electric motor mounted on the shaft which receives its current from the generator, the generator and motor driving



the ship at certain speeds, a low pressure turbine whose rotor is connected to the propeller shaft, means for admitting steam from the generator-turbine to the low-pressure turbine when it is desired to propel the ship at higher speeds, condensing means for the turbines, and means for cutting the electrical apparatus out of service and admitting steam to the low-pressure turbine when it is desired to maneuver the ship. Twenty claims.

1,100,420. SHIP'S STEERING GEAR. JAMES RICHARD CLAY, OF BOOTLE, ENGLAND.

Claim 1.—Steering gear of a ship comprising in combination a steering gear; a spindle fitted with a hand wheel for operating the gear, and with a pair of ratchet wheels having teeth oppositely formed; a pair of connected pawls disposed on opposite sides of the said spindle



and each engaging with one of the ratchet wheels; lever mechanism connected with the pawls; and means connected with the lever mechanism for operating the same, and for moving the pawls to and from the ratchet wheels, substantially as described. Two claims.

1,099,971. GUIDE BLOCK FOR TORPEDOES. WILLIAM J. DOOLAN, OF WASHINGTON, DISTRICT OF COLUMBIA.

Claim 1.—The combination of a torpedo spoon, a torpedo disposed in said spoon and slidably interlocking therewith, and means interposed between the interlocking portions of the torpedo and spoon for absorbing friction incident to the discharge of the torpedo irrespective of the direction of transverse strains exerted upon the torpedo during such discharge. Six claims.

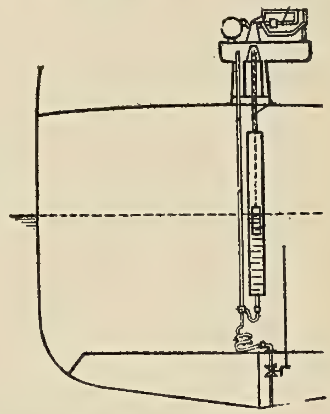
British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

13,755. APPARATUS FOR DISCHARGING ASHES AND OTHER MATERIALS FROM SHIPS. WILLOUGHBY LAKE BAYLAY, of BLACKHEATH, ASSIGNOR TO J. STONE & CO., LTD., OF DEPTFORD.

Claim 1.—Apparatus for discharging refuse from ships below the waterline comprising in combination, a receptacle for the refuse, a discharge duct, a valvular device between said receptacle and duct and adapted to alternately receive successive charges of refuse and to deliver same to said duct, a discharge connection between the valvular device and the duct, a water pipe discharging below the water line of the ship in connection with said duct and adapted to carry water past the delivery end of the discharge connection, a pump in connection with said water pipe adapted to produce a continuous stream of water therein, a compressed air supply pipe connected with the discharge connection in such a manner as to prevent water from rising into said valvular device, and means adapted to relieve the pressure from the valvular device prior to each opening of the valvular device to the refuse receptacle, substantially as set forth. Four claims.

26,993/1912. IMPROVED APPARATUS FOR SIMULTANEOUSLY WEIGHING THE CARGOES AND MEASURING THE DRAFT OF SHIPS. C. FINCK, OF HOHENZOLLERNRING 54, KIEL, GERMANY.

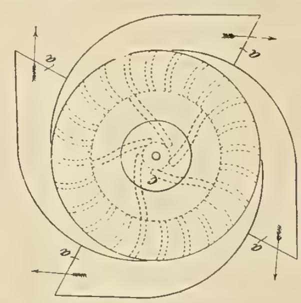
Comprises apparatus for measuring the loading of ships by means of a measuring member suspended away from the center of gravity of the ship from a balance, and forming, on a smaller scale, a reproduction of the ship's form, and capable of being raised or lowered through a distance, which depends on the slant of the ship and on the distance between the measuring vessel and the ship's center of gravity with the



existing condition of loading. A device for directly indicating the draft at several places in the ship's length, comprises essentially a pointer, actuated by a float, moving over scales adjusted by a water level, according to the trim of the ship. To determine the distance through which the measuring members must be raised or lowered when the ship is out of trim, a second device is employed consisting of a chart drum operatively connected to the water level to enable that distance to be read off.

27,642/1912. FANS FOR FORCING AIR INTO THE STOKEHOLDS OF TORPEDO BOAT DESTROYERS, ETC. W. H. ALLEN AND R. W. ALLEN, BOTH OF QUEEN'S ENGINEERING WORKS, BEDFORD.

Claim.—Relates to fans for forcing air into the stokeholds of torpedo boat destroyers and other small craft where the space is very limited, and consists in the combination with a fan of the type shown



situated at the top of a stokehold and wholly within it and sucking air through an inlet in the wall of the stokehold of a casing provided with one or more outlets delivering air at the top of the stokehold in a direction away from the deck and sides and the beams supporting them. One claim.

19,192/1912. APPARATUS CONTROLLING CLOSING OF BULKHEADS DOORS FROM A DISTANCE. W. G. GIBBONS, OF ROSEBANK IRON WORKS, EDINBURGH, AND J. BLAKE.

Claim.—This invention relates to bulkhead doors which close by gravity when released, the object being to provide improved and simple apparatus by which the clutches, pawls, etc., in the operating mechanism may be withdrawn from the ship's bridge. The apparatus comprises a disconnectable locking device in each door operating gear, means controlled by a spring and by a small hydraulic cylinder to operate the locking device, a large hydraulic cylinder at the transmitting station, valve or cock controlled pipe connections putting each of the small cylinders in connection with the large cylinder, means for operating the ram or piston of the large cylinder by power or by hand, or by both, an operating-fluid supply tank situated above the apparatus, a supply pipe connecting this tank with the large hydraulic cylinder, and means for closing the supply pipe on the inward movement, so that when hydraulic pressure is transmitted the locking device is withdrawn and the door is free to close. One claim.

1,109/1913. STEERING AND CONTROLLING STEAMSHIPS AND THE LIKE. S. WHITAKER AND S. W. COOPER, OF L, 49 ROYAL EXCHANGE, MANCHESTER.

Improved means for controlling the steering of steamships, etc., consists in the employment below the waterline of the vessel and at either the bow or stern or at both ends, of one or more pipes open at one end to the water at one side of the vessel and at the other end to the other side of the vessel for the exit of water, a rotary pump being arranged in each pipe for inducing a flow of water through each pipe from one side of the vessel and to discharge it at the other side.

International Marine Engineering

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An Abrupt Awakening

With the outbreak of hostilities in Europe the first world-wide industry to pay an involuntary and heavy toll was maritime commerce. Following the immediate closing of exchanges in the world's markets, the virtual blockade of the immense merchant fleet of Germany and the partial embargo of oversea commerce at the seaports of belligerent nations, ship owners, exporters, producers, manufacturers and merchants of neutral countries were brought to the sudden realization of the vast importance of an independent merchant marine, adequate in size and equipment to meet the needs of the nation to which it belongs. With the rapid advances that have been made in recent years in the development of means for ocean transportation, the whole world has become so interwoven with the sinews of commerce that scarcely a nation exists, no matter how remote, whose people have not become dependent for the continuance of their prosperity and welfare, in one way or another, upon the interchange of commodities with foreign nations. In the United States, where for a generation the majority of its ninety million people by the expression of their will in the halls of Congress have firmly resisted any attempts of far-sighted statesmen to establish an adequate foreign merchant marine, the awakening in the present crisis has been abrupt and is bound to be far-reaching.

Effect of War on Shipping

While the ultimate effect of the war on shipping will depend upon its duration and cannot be foretold, nevertheless its immediate effect has been destructive. The immense German merchant fleet, which comprises about 11 percent of the world's tonnage, has been literally swept from the high seas. Many of the large British and French ships, together with a considerable proportion of their officers and crews, have been withdrawn for war service. At the time of writing, a total of 82 vessels, mostly steamers, of which 63 are German, 8 are Austrian, 6 are British, 2 are Servian and 1 is Finnish, have been seized as prizes of war, while several merchant vessels, including the big German liner *Kaiser Wilhelm der Grosse*, have been destroyed. At the outbreak of war, with financial and commercial conditions reduced to the lowest limits by the closing of exchanges and derangement of credits, foreign commerce was virtually brought to a standstill. In the large seaports of neutral countries hundreds of men, such as stevedores, longshoremen, shippers and the crews of small harbor craft, all dependent upon shipping for their livelihood, were thrown out of employment. As the first shock of war passed over, however, readjustment began. Through the influence of Great Britain's enormous sea power, traffic across the Atlantic and through the Mediterranean became reasonably safe. The assumption of war insurance risks by the English and French governments aided greatly in paving the way for the resumption of foreign commerce in English and French vessels. Under war conditions, however, both the nature and volume of exports and imports of belligerent nations are radically changed. The domestic resources of combatants must be conserved, the inflow of necessary supplies assured, and the export of staples and manufactured products seriously curtailed. Simultaneously, however, an extraordinary opportunity is given to neutral nations to acquire a large share of the world's trade, hitherto carried on by the belligerent nations. In the present instance, in the United States especially, the call from South America, the Orient and also from the warring nations for staple and manufactured products, foreshadows a commercial future for the country far greater than has ever been presented before. While the bulk of the world's sea-going tonnage is still available for commerce, and will in time be accessible owing to the diminished volume of foreign commerce from the countries involved in war, nevertheless it is clearly evident that the chances for the United States to grasp this extraordinary commercial opportunity would be tremendously enhanced by the existence of an American merchant marine adequate in size to deal with an immediate expansion of its commerce across the seas regardless of hostilities in foreign countries.

Emergency Measures

Although immediate steps were taken in the United States to deal with the precarious situation created by the partial suspension of foreign commerce and the consequent congestion of export goods at the Atlantic seaports, very little actual progress has as yet been made in solving this complex problem. The most important action taken so

far is the enactment of a law admitting to American registry for overseas trade foreign ships bought and owned by American citizens or corporations. This is a step in the right direction, but in itself is ineffectual and unlikely to add much sea-going tonnage to the American merchant marine until a thorough revision of the United States navigation laws has been made and such restrictions removed as at present make the cost of operation of American ships so much greater than that of vessels flying foreign flags. Under the law as passed, the President is authorized to suspend at his discretion for such length of time as he deems desirable certain provisions of the navigation laws relating to the requirements for officers and crews of American ships, the eligibility of foreign officers for service on such ships, and also certain provisions relating to the measurement and inspection of American vessels. Until the administration has made known its definite decision in this respect, ship owners will be forced to postpone any changes of registry which they may contemplate. If the action of the administration is favorable, it is probable that a hundred or more American ships flying foreign flags will speedily be transferred to American registry, including many of the ships owned by W. R. Grace & Company, the United States Steel Corporation, the Standard Oil Company and the United Fruit Company. It is fortunate that the provision in the above measure as originally proposed, to admit foreign built ships to the coastwise trade of the United States, was decisively defeated. Such a course of action would have been extremely detrimental to the shipbuilding and steamship interests in the country and imposed upon them unnecessary hardships. Another emergency measure which seems both desirable and necessary is now under consideration in Congress which provides for the establishment of a Bureau of War Risk Insurance to cover American cargoes and American ships. Its purpose is to assume the war risk on vessels flying the American flag or carrying American cargoes whenever it is impossible for the ships or cargoes to get insurance from private companies on equality with vessels of other countries which issue war insurance. It is not intended that the Government shall compete in any way with private companies engaged in general marine insurance, and the Bureau of War Risk Insurance will be discontinued as soon as hostilities cease. Other proposals have been made, providing for government ownership of vessels for foreign trade, but so far these proposals are not looked upon with favor, because it is held that such a course will not only discourage private enterprise from entering the shipping field, but will also be harmful to American shipping in general and prove of little permanent value. It is highly desirable that any steps which are taken to improve the American merchant marine should be of permanent and lasting value and provide a basis on which a merchant marine can be developed on a paying basis as the foreign trade of the country expands.

The American Merchant Marine

One of the most important proposals that has yet been made in connection with plans for restoring the American merchant marine in foreign trade is the recommendation, widely indorsed by shipping and steamship interests, for the establishment of a permanent advisory board or council composed of men thoroughly experienced in shipping and steamship affairs to serve in the same capacity as the marine departments of the British and German boards of trade. Such a branch of the Federal government would be competent to deal intelligently and efficiently with provisions for merchant shipping—something which past experience has shown that a poorly advised and partisan Congress cannot be expected to do.

Hitherto Congress has allowed the navigation laws of the United States to become so encumbered with burdensome restrictions that it has been impossible for American ships to compete successfully with more cheaply operated vessels of other nations. For this reason the emergency measure admitting foreign built ships to American registry cannot prove effectual until the navigation laws have been thoroughly revised and American ships placed on a more equal footing with the merchant fleets of other nations. While some relief in this direction will be given shortly by the powers invested in the President to suspend temporarily certain provisions of the navigation laws, yet something more radical and far-reaching is required before the future of the American merchant marine is assured. For this purpose the creation of an advisory board such as has been outlined would be of inestimable value not only in revising the present laws, but also in laying the foundation for the future regulations on which a new American merchant marine can be built.

Among the provisions in the existing laws which place unnecessary burdens on American ship owners are the requirements for larger crews, for a number of officers in excess of that required by other nations, for a system of measurement by which the tonnage of American ships is far greater than that of ships under foreign flags, with consequent higher port charges, and certain regulations regarding the inspection of both hulls and machinery which impose further burdens without increasing the safety of the vessels. The rules which require adequate quarters and conveniences for the crew, which regulate the hours of employment and provide improved sanitary conditions, are praiseworthy features and have been brought about through painstaking endeavors to secure adequate protection for seafaring men and the general public dependent upon their work.

As to the tentative proposals for government-owned ships to meet the exigencies of the present emergency and to form the nucleus of a future foreign merchant marine, so far as plans of this nature have as yet been disclosed, the objections raised in all quarters seem to outweigh any benefits that might accrue for such a

scheme, although further disclosures may throw a different light on the question. The most insistent objection, that such a procedure might involve the United States in complications with some of the belligerent nations during the war, either through the purchase of vessels owned by the belligerents or through the transportation of contrabands of war, and thus impair the strict neutrality of the nation, is too important to be lightly thrown aside.

Liverpool Dock Improvements

The tendency of all foreign ports to adopt similar terminal plans, as well as the same methods of freight handling, is of great interest. Formerly, as there were no accepted rules, each port engineer usually followed out his own ideas. While most ports on the Continent had practically agreed that certain designs were the best, Liverpool remained the exception.

On July 2, 1914, the Mersey Docks and Harbor Board of Liverpool adopted a large scheme of dock improvements which will cost $1,102,262 (£226,000). The chairman of the Board stated that the plan will be a new departure for Liverpool, in that the shed will be set back from the water's edge with space for two lines of car tracks and for the rails of the cranes. It was thought by the majority of the members of the dock board that, as this principle is in active operation in so many ports, it would be well for them to have it at Liverpool. The shed will be 150 feet wide, 1,500 feet long, located on the South Quay of the new Gladstone Dock No. 1. There will be an equipment of twelve electrical discharging cranes on the dock side and ten electrical loading-off cranes on the road side.

Liverpool was almost the only progressive port remaining which continued to build sheds close to the quay's edge and to build expensive sheds to house in railway tracks or dray space which it is now determined should be outside the shed. The old plans of shed construction prevented the installation of the best types of freight handling machinery. Outbound cargoes arriving in cars must be trucked from the cars to the edge of the pier, and also that portion of inbound freight not requiring assorting, which could have been swung to the cars by one movement, must also be trucked.

In general, it may be said that the plan now adopted by the majority of marine terminal engineers is to design the piers or quays of sufficient width so that there can be two or three lines of railway tracks or a roadway between the shed and the quay wall, with additional tracks or a roadway to the rear of the shed. The transshipment shed should have sufficient capacity so that there can be temporarily stored, if necessary, the whole cargo of a ship opposite the ship's berth. This shed holding capacity can be obtained by adding to the width or height by mechanical high tiering or by using several stories. Where it is not possible to have surface track connections, there should be a dray space between the shed and the water, and service can be obtained by motor or horse drays in the place of the railway cars.

This position taken by the Mersey Docks and Harbor Board should prove instructive to port commissions in the United States.

Propelling Machinery of the Nevada

The propelling machinery of the United States battleship *Nevada*, whose launch at the Fore River shipyard was recorded in our last issue, consists of an improved type of Curtis turbines, placed in four watertight compartments, arranged for twin screws. These turbines are designed to develop 26,500 shaft horsepower at 222 revolutions per minute. Each line of shafting is driven by a high-pressure turbine in the forward compartment, and a low-pressure turbine in the after compartment. Each high-pressure turbine is connected to its low-pressure unit by a 28-inch diameter exhaust pipe. In the after end of each low-pressure turbine there is built in a reversing turbine which exhausts through the common exhaust pipe to the condenser.

On the forward end of each high-pressure turbine shaft there is located a cruising turbine with reduction gear. These cruising turbines are designed to develop 2,750 horsepower at 3,200 revolutions per minute. The reduction gear has a ratio of 23.3 to 1, and thus drives the main propeller shaft at 137 revolutions per minute, which corresponds to a cruising speed of 13½ knots. The reduction gear is connected to the main turbine shaft by means of a clutch easily operated from the working platform. The main bearings and horseshoes for thrust bearings are provided with forced lubrication and water service.

The auxiliaries, consisting of condenser, air pumps, feed tanks, main circulating pumps, feed water heaters, etc., are located in the engine rooms. The condenser and air pumps are designed to maintain, under full power condition, a vacuum of 93 percent of absolute.

Arranged forward of the engine rooms are three firerooms, each containing four watertube boilers of the Yarrow type, designed for oil burning by mechanical atomization in the burners. The boilers are designed for a pressure of 295 pounds gage, which drops to 265 pounds gage at the main turbines.

The fuel oil system consists of the necessary piping, together with pumps, heaters, etc., each boiler being fitted with an emergency automatic shut-down valve in case any breaks in the fuel oil piping should occur.

The air for combustion is furnished by forced draft blowers, discharging air into the firerooms, which are of closed stoke-hold type. The blowers are designed to maintain the maximum rate of combustion, the number of revolutions not exceeding 1,050 per minute.

The machinery of the *Nevada* is noteworthy in that it is the first installation of high-speed geared turbines for cruising purposes on a United States battleship, and because of the opportunity it affords for comparison with a sister ship propelled by reciprocating engines.

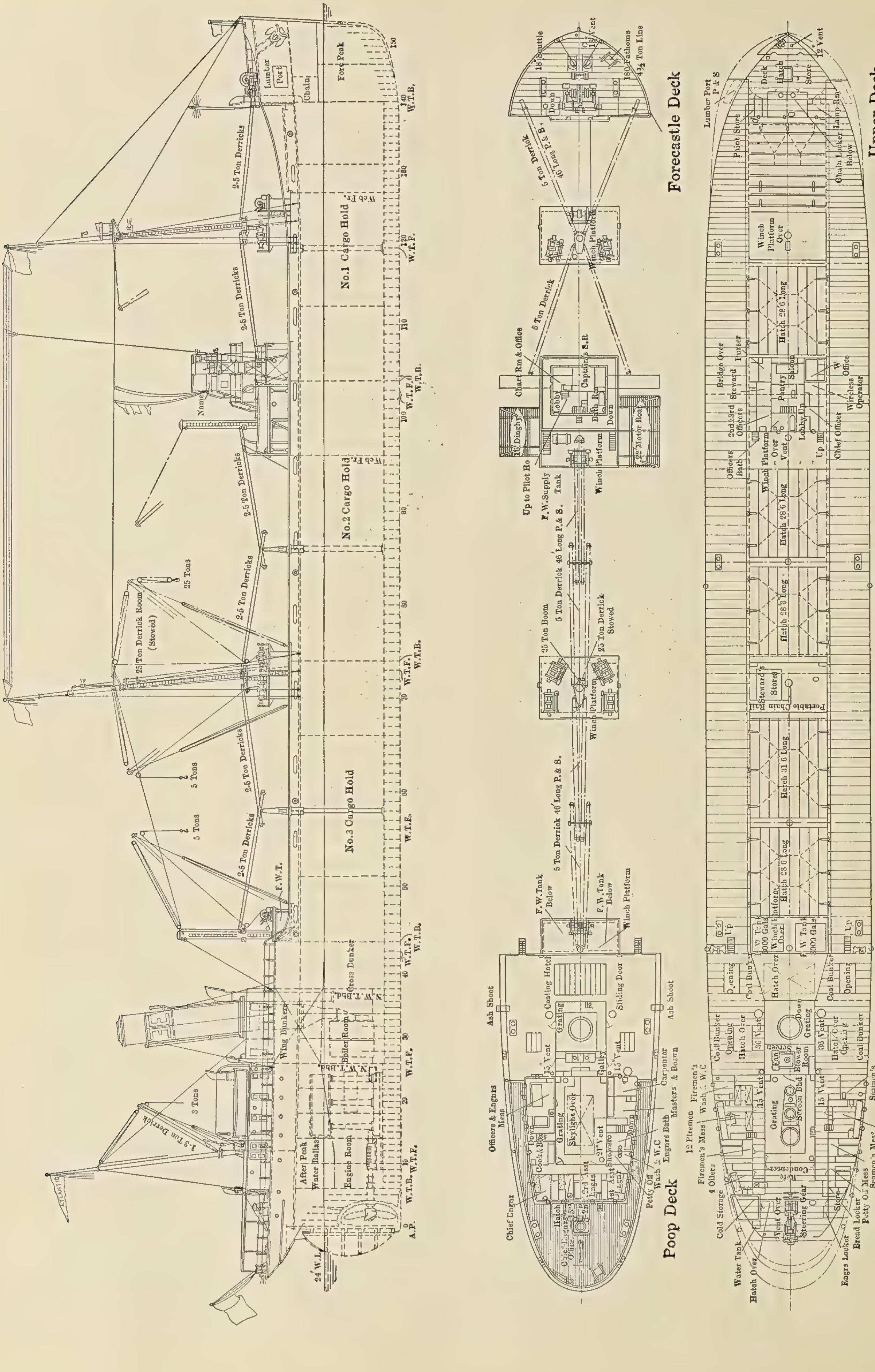


Fig. 1.—Profile and Deck Plans of the Steamship *Atlantic*, Built by the Fore River Shipbuilding Corporation, Quincy, Mass., for the Emery Steamship Company, of Boston

New Freighters for the Panama Canal Trade

Description of the Freight Steamers Atlantic and Pacific, Just Completed by the Fore River Shipbuilding Corporation for the Emery Steamship Company

The steamship *Atlantic*, whose plans are reproduced herewith, is one of the two sister steamships recently completed by the Fore River Shipbuilding Corporation of Quincy, Mass., for the Emery Steamship Company of Boston to the designs and under the supervision of Mr. George Simpson, naval architect, New York city. The *Atlantic* has embodied in her design a number of new features with a view to the special trades in which she will be engaged, namely, as a bulk carrier or as a lumber carrier. The principal dimensions are as follows: Length overall, 405 feet 9 inches; length between perpendiculars, 388 feet; breadth, molded, 54 feet 4 inches; depth, molded, 31 feet 8 inches; load draft, 24 feet 9 inches; deadweight capacity, 9,000 tons.

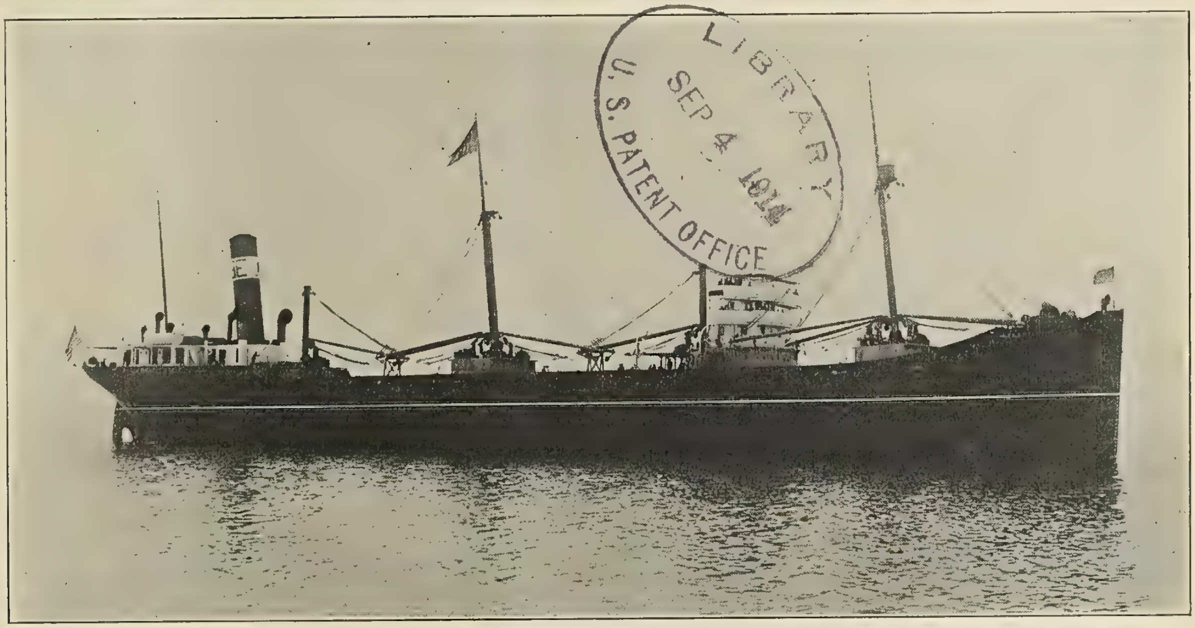


Fig. 2.—Bulk Freight and Lumber Carrier *Atlantic*

The Emery Steamship Company ordered these vessels specially for their Boston-Seattle trade via the Panama Canal, and in view of being employed on the eastward run in the lumber trade, special consideration has been given to stowing lumber cargo in long lengths, as well as shipping the longest sticks of Douglas fir carried as a deck load. In this connection this vessel is a striking commentary on the regulations at present under consideration in England, Germany and Spain, with a view to determining the advisability or otherwise of permitting vessels engaged in the lumber trade to carry deck loads. Americans conversant with the lumber trade believe strongly that vessels constructed for carrying deck loads, such as have been in operation on the Pacific coast for many years, ought not to be disbarred from carrying these loads in the manner which experience has demonstrated to Pacific coast operators as being safe and sane, namely, that sufficient stability be given the vessel to carry a superimposed load with special arrangements for securing that load so that it cannot change in any contingency likely to be experienced.

An examination of the *Atlantic's* plans will show that this feature has been specially taken care of in the preparation of the design, as the three large holds into which the vessel's hull proper is divided have been constructed without any obstructions whatever, enabling the hold cargoes to be efficiently and economically stowed. For the deck load, provision has been made by making not only the midship quarters in the form of an inland house, and by similarly constructing the forecastle, enabling long spars to be shipped through the large lumber ports in each bow and passed along the deck for an unobstructed length of 300 feet. The island feature of these two erections, together with solid boatswain storehouses at the base of each mast, affords a splendid support to the lateral movement of the deck loads, which, in combination with the Pacific method of securing the load, when properly stowed on deck by chains secured to the sheerstrake and passed over the load from side to side with turnbuckles to take up the slack, results in building a deck load which has all of the stability and homogeneity of an erection itself.

The *Atlantic* has been constructed on the familiar type of American freight vessels, with the propelling machinery located aft and the remainder of the hull forward of the machinery space devoted entirely to cargo carrying purposes. The cargo holds are three in number, each 90 feet in length, the construction being on the deep frame principle with arch frames at the mid length, these latter being supported by large columns. The cargo hatches are exceptionally large, consisting of two hatches to each hold, each hatch being 30 feet in length by 25 feet in width. The side coamings of these hatches are continuous and carried about 3 feet above the deck, the covers themselves being of steel in two pieces, divided along the centerline, opening outwards and resting horizontally on the port and starboard rails respectively. These hatch covers are on DeRusset's patented principle, which have been fitted to a large number of American cargo ships as well as to the

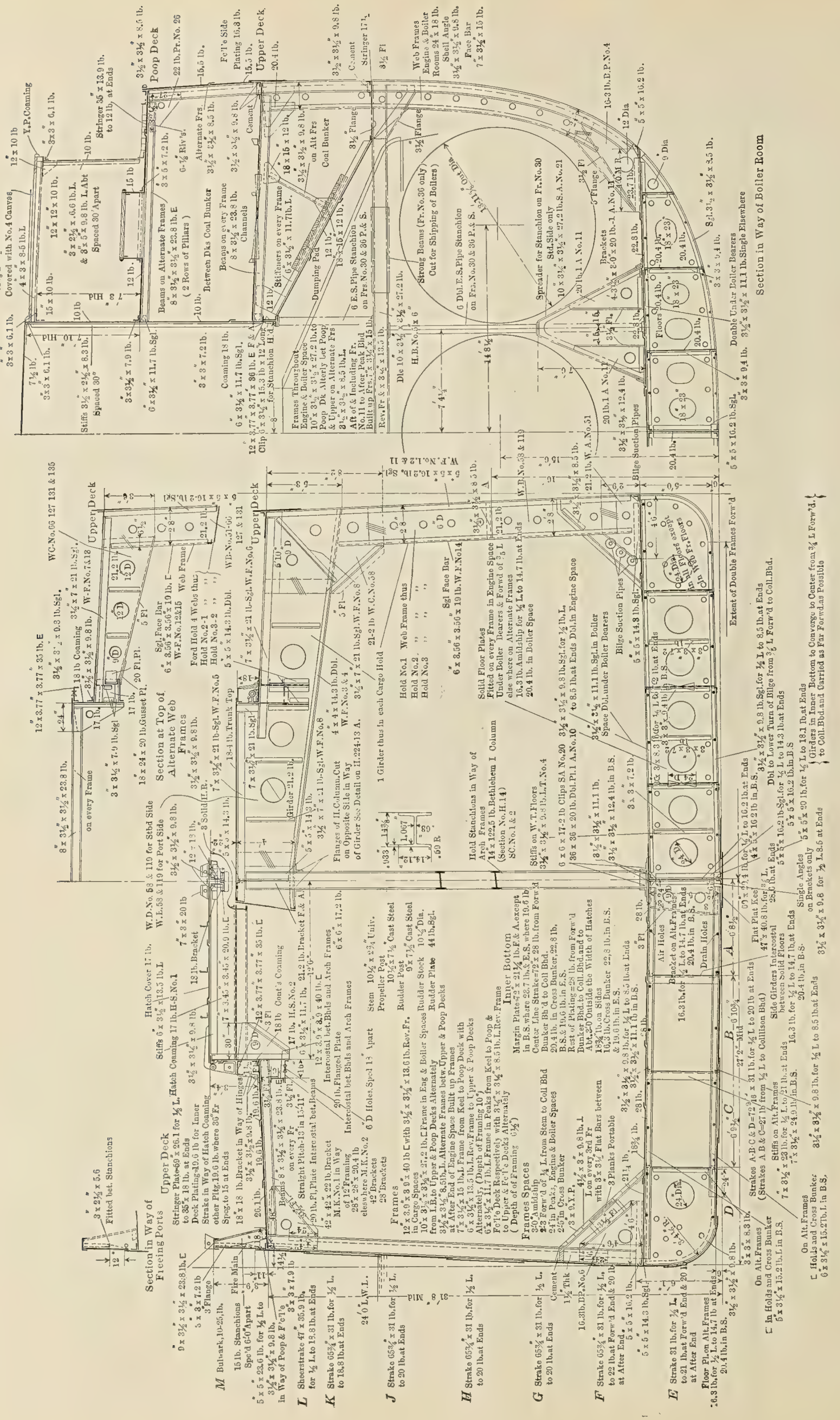


Fig. 3.—Midship Section of the *Atlantic*, Showing Scantlings

14,000-ton United States naval colliers. In fact, this type of hatch cover would seem to be a greater favorite in America than in the country of its origin.

The cargo discharging appliances consist of nine double drum friction winches made by the Lidgerwood Manufacturing Company, and capable of exerting a pull of 8,000 pounds on a single whip. As these winches are founded on high deck houses at the base of each mast, they enable a deck load to be carried and properly discharged without interfering with the operator, who, it will be noted, is in quite a commanding position to handle the deck load safely and conveniently. After the deck load has been disposed of, the hatch covers are opened by the cargo falls and rested on the main rail as previously described, enabling the operator to get at the hold cargo and discharge it.

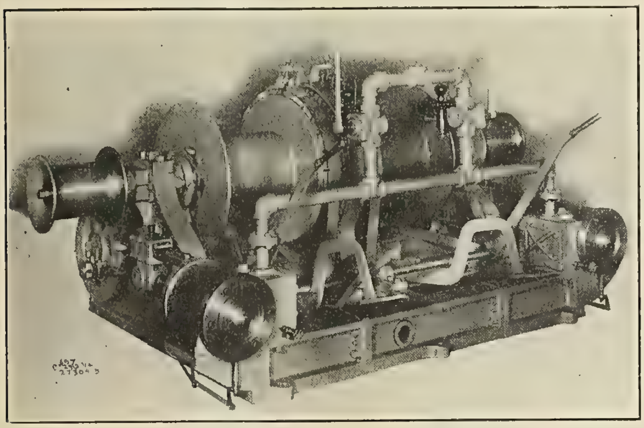


Fig. 4.—Lidgerwood Cargo Winch

Each winch has two independent friction drums and two winchheads. The levers are all brought to the rear, having the lead for the ropes all clear. There is an independent throttle lever for each side, a hand lever for each friction and a foot lever for each brake. This permits of each drum being operated independently so that with two operators each winch is really two winches, but with the advantage that when an extra heavy load is to be handled the whole power of the engine can be used for the load on one drum. There are two cylinders 8¼-inch diameter and 8-inch stroke. The drums are 14 inches in diameter with 14-inch faces. With both drums loaded the lifting capacity on a single line is 2,500 pounds on each drum, but a 5,000-pound pull can be had on either line, working with only one drum. This type of winch is capable of very rapid cargo handling.

The machinery spaces aft are enclosed by a long loop surmounted by a steel Liverpool house affording accommodations for the engineers, petty officers, and mess rooms with other conveniences, and below deck, port and starboard are berthed the firemen and seamen. The boilers have been arranged three abreast, and the fuel carried in a cross bunker with 'tween deck bunkers in the wing spaces, giving a total capacity of about 850 tons of coal.

Special attention has been given to the water ballast arrangements to provide a much larger amount than is usual in this class of vessel, which has resulted in fitting a 5-foot inner bottom on the bracket and solid floor construction throughout the hold spaces, and a 6-foot inner bottom under the machinery spaces.

It will be noted that the vessel has been rigged with three pole masts, the fore and main masts being of steel and equipped, in combination with two king posts, with thirteen 5-ton derricks and one of 25 tons working capacity, enabling the vessel to be expeditiously loaded and discharged.

The deck auxiliaries consist in addition to the winches already mentioned of a combined steam windlass mounted on the forecastle head, a steel screw and hand steering gear with telemotor control of the Lidgerwood design from pilot house and flying bridge to the engine aft, as well as hand control gear from top of poop deck house. There has also been installed a one-ton Brunswick ice machine, a reversible steam capstan on the poop deck, and an efficient system of steam heat radiators.

The steering engines are of the "screw gear" type. One of them is clearly shown in Fig. 5, together with the telemotor, as they were set up for test in the shops of the Lidgerwood Manufacturing Company. The telemotor is oil filled and is of the standard type with some improvements in details. The steering engine has all spur gearing. The screw for operating the tiller has square threads, highly finished. There is a "trick" wheel for steering by steam at the engine and hand-steering wheels which can be thrown into gear and the steam end disconnected quickly should hand steering become necessary at any time.

One of the little things tending toward safety on Lidgerwood steering engines is that the bolts are all double nutted, the engines have large "save oils," and all the working parts are highly finished and fitted by hand scraping. The connecting rods have the expensive but easily adjusted strap ends with gib and key adjustment and other features peculiar to the Lidgerwood "duplicate part" built engines which have given them their high reputation for durability and efficiency.

The propelling machinery consists of a set of vertical inverted triple expansion engines with cylinders 25 inches, 41 inches and 68 inches in diameter, having a common stroke of 48 inches and driving a right hand propeller at 75 revolutions per minute. Steam is supplied at 190 pounds working pressure. The cylinders are mounted on hollow cast iron columns of box section, and a separate condenser of wrought steel plate of the cylindrical type is installed. The high-pressure cylinder only is fitted with piston valves and the intermediate- and low-pressure with double ported slide valves.

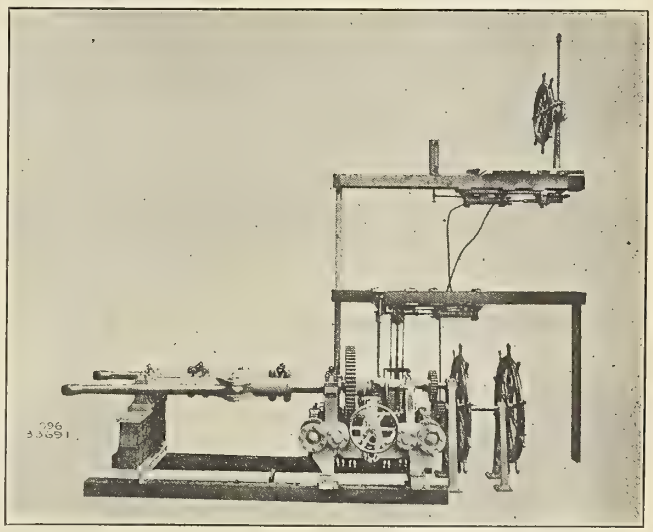


Fig. 5.—Complete Steering Gear Before Installation

The valve gear is of the Stephenson link type. The reversing engine is a direct-acting cylinder, operating a forged steel shaft carried in a bearing bolted to the back columns. The turning gear consists of a single cylinder

engine driving through worm gearing shaft mounted on a sliding cast steel worm.

The propeller is of the built-up type, having a cast iron hub and four removable cast steel blades, the design conforming with Commander Dyson's improved navy type, which has proved highly efficient on previous service tests.

The air pump is of the Edwards type bolted to the back column of the engine. This pump is 24 inches in diameter by 20-inch stroke. The bucket and delivery valve seats are of copper with metallic valves and composition valve guards and nuts. The pump rod is of steel covered with brass and secured to the bucket by a taper fit with a composition nut pinned on. This pump has 9 inches diameter discharge to the feed tank.

There are two high-pressure feed pumps of the Worthington Admiralty pattern of the vertical duplex type with composition water ends. These pumps are 9 inches by 6 inches by 10 inches, and are arranged to draw from the sea, reserve feed tank, main air pump, auxiliary condenser, feed tanks and boiler bottoms. There is one ballast pump of the Worthington vertical duplex ballast pump type 10 inches by 12 inches by 10 inches with cast iron water ends.

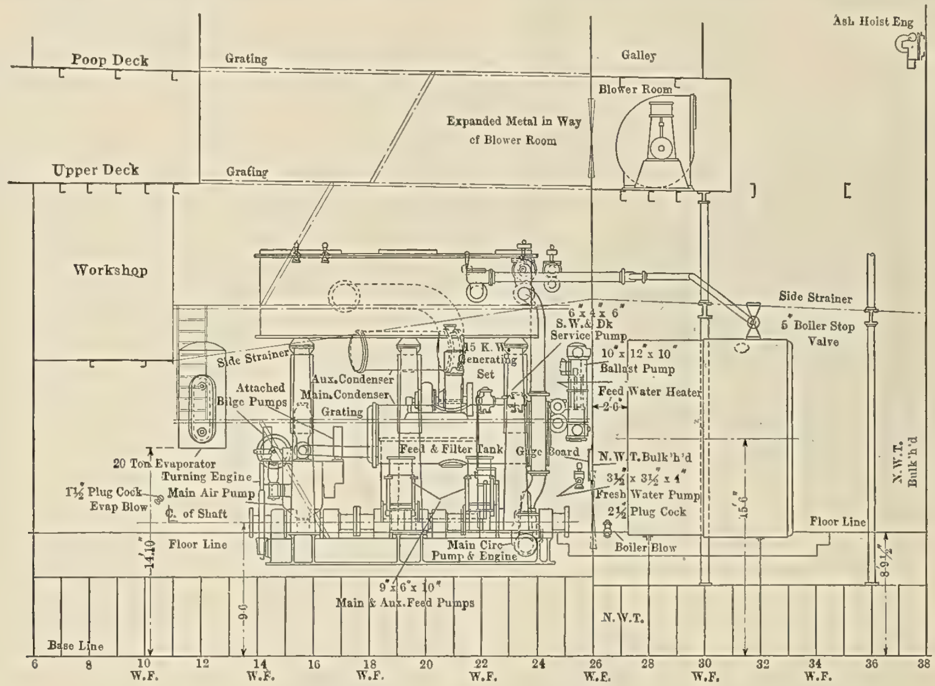


Fig. 6.—Longitudinal Section Through Machinery Space

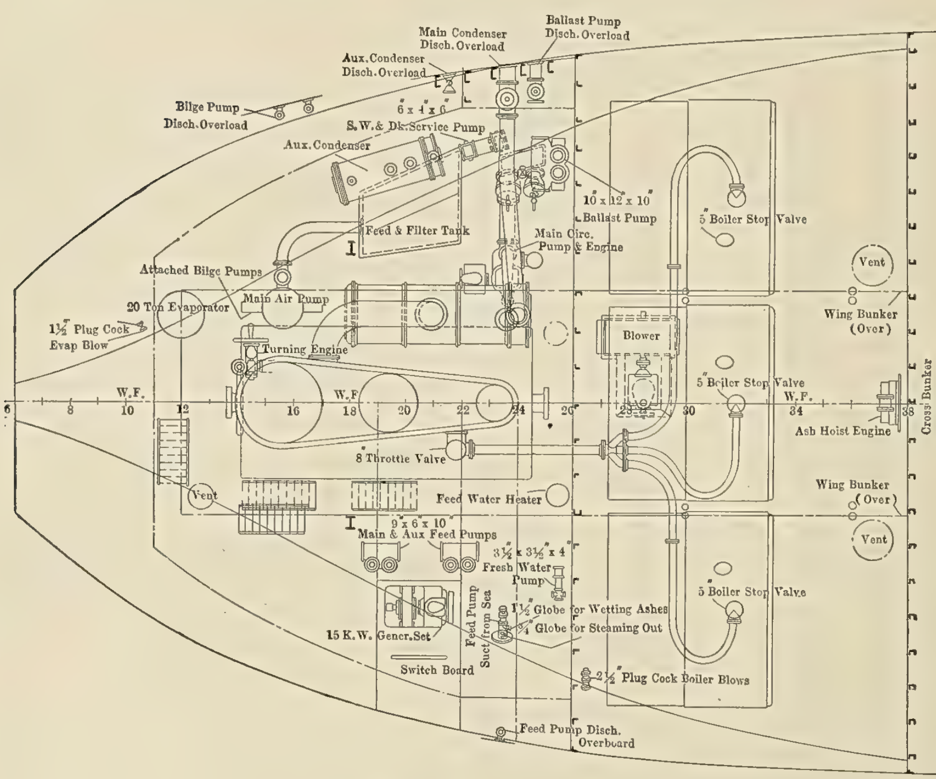


Fig. 7.—Plan of Machinery Arrangement

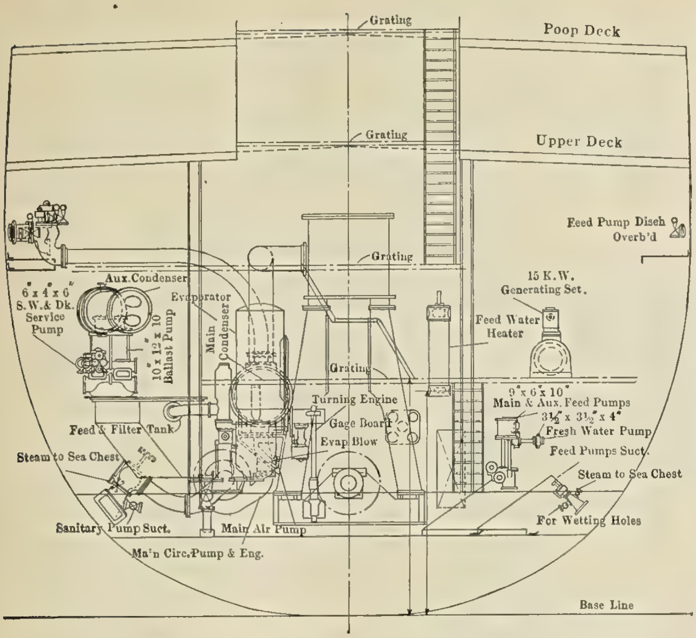


Fig. 8.—Section Through Engine Room

The main boilers are of the Scotch marine type, single ended, and three in number arranged abreast. They are 13 feet 9 inches in diameter by 12 feet long, and have a combined grate area of 155 feet and a total heating surface of 6,500 feet, the ratio being 1 to 42. Each boiler has three corrugated furnaces of the Morison suspension type 42 inches inside diameter. The safety valves are of the

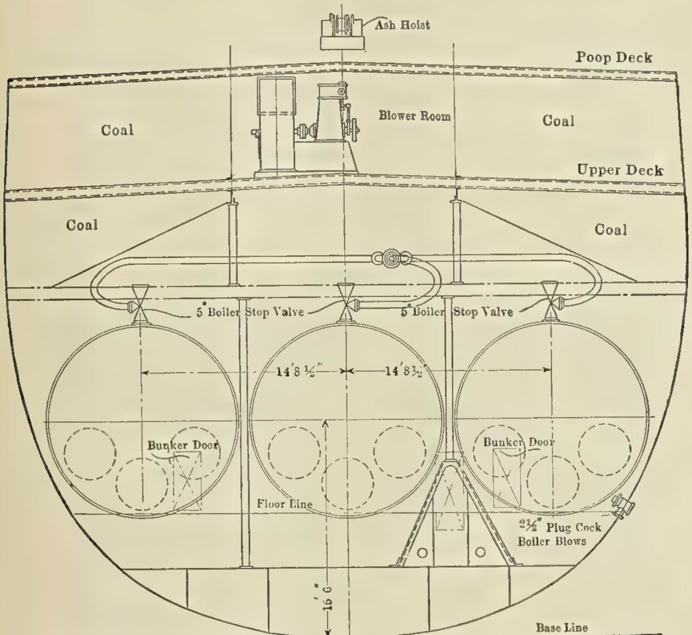


Fig. 9.—Section Through Boiler Room

twin type made by the American Steam Gauge Manufacturing Company. A forced draft installation operated by a Sturtevant fan is provided.

The electric light plant consists of one multiple-phase 6-pole, 15 kilowatt, 115 volt, direct connected General Electric Company marine generating set with a combined generating and distributing switchboard. The distribution is on the two-wire system and supplies current to one 18-inch searchlight and 180 16-candlepower incandescent lamps, as well as the running and signal lights.

The wireless installation is of 2 kilowatt capacity, capable of transmitting messages to a radius of 300 miles, and is supplied from the main generator.

Both hull and machinery have been constructed in conformity with the highest class in Lloyd's Register of Shipping, and the vessel has been supervised during construction by the officers of that society.

It will be found that the *Atlantic* and her sister ship, the *Pacific*, which is about to be launched, are in a class by themselves as far as the bulk carrying and lumber trades in the American coastwise service are concerned. It is doubtful if there are any vessels especially designed for this particular trade approaching them in size, as the *Atlantic*, with a moderate deck load, will carry 5,000,000 board feet of lumber, or alternatively a total bulk deadweight of 9,000 tons, at a speed of 10½ knots at sea on a low consumption of fuel.

Lundin Power Lifeboat Equipped for a Voyage Across the Atlantic

On July 30 a 36-foot Lundin steel power lifeboat, manned by a crew of six, left New York harbor for a voyage to Queenstown and adjacent ports via Halifax and St. Johns, Nova Scotia. With the outbreak of war, however, soon after the boat reached Boston, Mass., the transatlantic voyage was discontinued and the boat returned to New York to wait until hostilities have ceased.

The boat in which this venturesome voyage was begun

36-Foot Lundin Power Lifeboat

is a standard power lifeboat of the type designed by Captain A. P. Lundin, president of the Welin Marine Equipment Company, Long Island City, N. Y. It is 36 feet long, 12 feet wide, with a draft of 27 inches, and weighs 18,900 pounds. The hull is built entirely of galvanized sheet steel and is flatt-bottomed and flat-sided, with fenders of Balsa wood 1 foot thick on each side. Thirty-four inches above the bottom is a steel deck, the space between the bottom and the deck being partitioned off by steel bulkheads into ten air-tight compartments. Access to each

of these compartments is possible by circular removable covers clamped down on hatches in the steel deck. Automatic scuppers drain through pipes leading down through the bottom of the boat any water that may be shipped.

Amidships the boat is entirely housed in with a steel deckhouse with the ends beveled and fitted with watertight doors, giving access to the cabin. The roof of the cabin is strengthened by eight U-shaped frames of metal in the form of arches, crossing from side to side inside, while outside eight fore-and-aft strips of the same shape of metal are run along the cabin top. Wooden gratings cover the metal floor and eight specially designed ports, four on a side, furnish light for the interior. These swing open to admit air or they may be clamped down watertight, while a separate flap at the bottom of each port may be raised, permitting oars to be used even when the ports themselves are closed. Two masts, 30 feet long, are hinged to fold down on the cabin top in case of bad weather, to permit stowing the boat on the deck of a steamship. Besides the aerial for a wireless outfit, the masts carry two staysails, two trisails and two jibs.

Propulsion of the boat is by a propeller, 27 inches diameter by 39 inches pitch, housed in a tunnel built in the bottom of the hull aft. The motor, which is a four-cylinder, 6 inches by 8 inches, 32 to 37 horsepower Standard gasolene (petrol) engine, manufactured by the Standard Motor Construction Company, Jersey City, N. J., is installed in a covered steel box compartment, 8 feet 3 inches long and 3 feet 6 inches wide, its forward end being 20 feet 7 inches from the stern. The controls for the motor are alongside the helmsman, both the clutch and throttle levers being on one standard. Two 230-gallon seamless steel tanks for gasolene (petrol) are supported on leather-lined steel saddles strapped fast in the bilge compartment on either side of the motor box. A pump on the motor raises this fuel to a small feed tank in the forward port corner of the motor box, where it feeds by gravity to the vaporizer. For the transatlantic trip, extra boxed cans of gasolene (petrol) were stowed in the various air-tight compartments in the double bottom. Fresh water is carried in two cylindrical tanks of 100 gallons capacity each, sunk level with the floor just aft of the engine compartment.

In a silent cabin built of Balsa wood in the forward end of the cabin on the starboard side is installed a complete Marconi wireless outfit, capable of transmitting messages 100 miles and receiving messages from 600 to 1,000 miles. The wireless outfit is identical with that installed in the United States submarines. Electricity is generated in a 110-volt direct current dynamo belted to the flywheel of the motor. The electrical equipment also includes a complete Dayton electric light outfit with a 3½ kilowatt, 110 volt dynamo supplying current for lighting the boat, for cooking, and also for a 7-inch Carlisle & Finch searchlight.

Ventilation is provided by air vents in the top of the house, so designed that they will automatically close if turned upside down. One of these, fitted with a cowl, is over the wireless room, two are over the main cabin, one of which feeds air through a pipe down into the forward end of the engine compartment. A blower belted to a pulley on the shaft at the after end draws air out and up through a vent over the after end of the engine box. Two vents are installed in the after end of the cabin.

The crew for the transatlantic voyage consisted of Mr. E. Sivard, superintendent of the Welin Marine Equipment Company, and his bride; Captain B. A. Rigoulot, navigator; Charles Klentberg, assistant navigator; Walter Petersen, engineer, and H. J. Meldrum, wireless operator. All of the crew were experienced men and little difficulty was anticipated in making the long voyage in such a small boat, for repeated tests under a great variety of conditions have shown that the boat is thoroughly seaworthy and reliable for the roughest kind of work. The boat has been approved and passed by the United States Steamboat Inspection Service and rated for a capacity of 100 persons.

Aero Automatic Fire Alarm

A fire-alarm system that will detect and announce a fire, together with its location, within a few seconds after the fire has started, and that is adjustable to operate under any conditions, and also discriminate as adjusted between a gradual and a sudden rise of temperature, is being manufactured and installed by the Aero Automatic Fire Alarm Company, 6 Church street, New York.

This system, simple in theory and decidedly practical and effective in operation, is exactly contrary to the action of any thermostat system, which is necessarily sensitive to local heats and takes no cognizance of how widespread a heat may be. "Aero" might, therefore, be termed "the

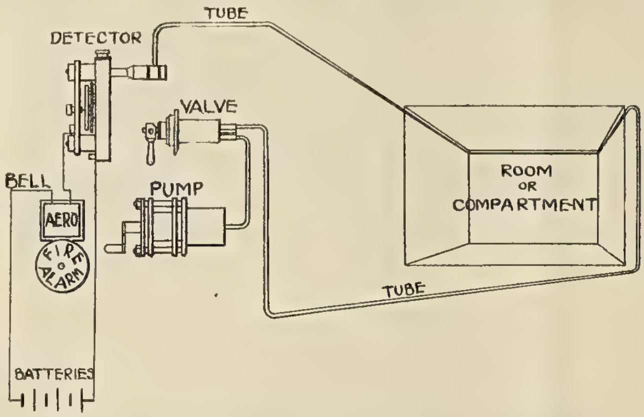


Fig. 1.—Diagrammatic Sketch of Aero Fire Alarm System

universal thermostat." It consists essentially of a fine capillary tube, filled with air at atmospheric pressure, connected to a delicate pressure recorder in the form of a diaphragm and, in series with these, a compensating device in the form of an adjustable vent or leak. The center of the pressure recorder diaphragm forms one point of contact in an electric circuit which is closed by a very minute expansion of the diaphragm. The vital part of any fire alarm consists of its operation up to this point, that of closing the circuit, after which the system's accomplishments are unlimited.

The tube, which is copper, is of very small bore, so that it will present a very large ratio of heating surface to air contained. It is almost impossible to render the tube inoperative, since it is only necessary to have a very small opening through any section of the tube where it might become bent or twisted so long as the section is not made air tight. The whole system may be tested with absolute certainty by means of a pump arrangement creating a slight increase of pressure throughout the tube. If there is no leak in the system, and if there is communication throughout, a slight pressure caused by the pump will operate the alarm, and in this manner the whole system may be tested in a few seconds at the alarm station.

The compensating device or vent is in the form of a porous washer held in place and adjusted by a screw. Tightening the screw decreases the size of the pores in the washer, and therefore renders the whole system more sensitive. In other words, the washer, as set for given conditions, allows air in the tube to escape at a certain

rate when the pressure of that air attempts to rise above that of the atmosphere. A rise in temperature will cause the air in the tube to expand at a certain rate dependent on the rate of rise of the temperature and independent of the initial temperature. Therefore, if the rate of rise of temperature will cause a rate of rise of pressure in the tube that is greater than the rate of escape of the air in the vent, then the alarm will be sounded by the diaphragm expanding to complete the electrical circuit. This a complete system of tubing, vent, detector, etc. On board the *Washington Irving,* of the Hudson River Day Line, New York, where a complete Aero automatic fire alarm system was installed, the ship is divided into sections forward and aft on each deck and in the hold. Each section has its line of tubing, leading to the main annunciator with a separate detector for each section, so that when the alarm sounds the board lights up showing the deck and location on that deck with respect to amidships of the

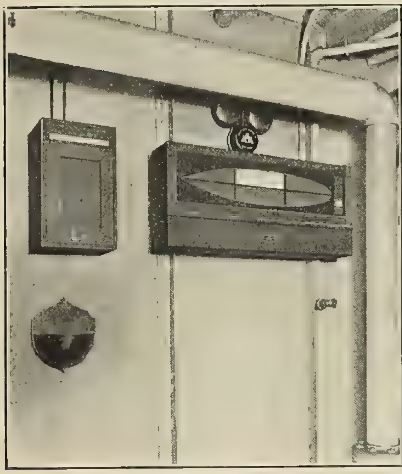


Fig. 2.—Sub-Station in Engine Room

Fig. 3.—Main Switchboard on Deck, Open, Showing Detectors, Testing Air-Pump, Valves and Circuit Signals

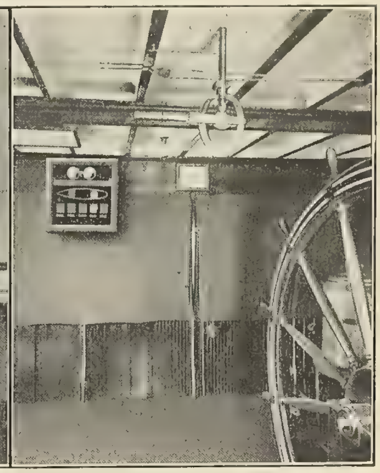


Fig. 4.—Auxiliary Annunciator in Pilot House

naturally furnishes an ideal system for fire alarm on board ship, since it is adaptable to all conditions of temperature and will take care of refrigerating room and boiler room equally well.

The applications of the "Aero" system here shown give an idea of its unlimited use and adaptability, not only in marine service, but under any conditions where an alarm should be installed, as, for instance, on a steamship pier or in a warehouse.

The system as installed comprises a number, each unit

fire. As the *Washington Irving* is a day boat, its decks are most all wholly open, and therefore it is not necessary to further divide the system, since a fire can easily be seen if its general location is known.

On the *See and Bee,* of the Cleveland & Buffalo Transit Company, Cleveland, Ohio, which is not only the largest passenger vessel on the Great Lakes, but also the largest side-wheel steamer in the world, a complete system of the Aero automatic fire alarm has also been installed. On this vessel it became necessary to subdivide the boat to a

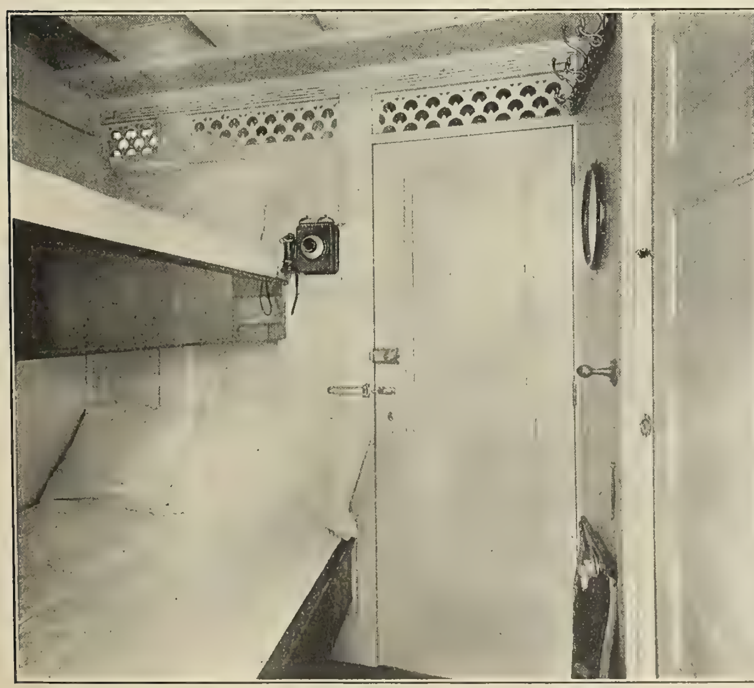


Fig. 5.—Stateroom, Showing Tubing Looped Over Ventilators

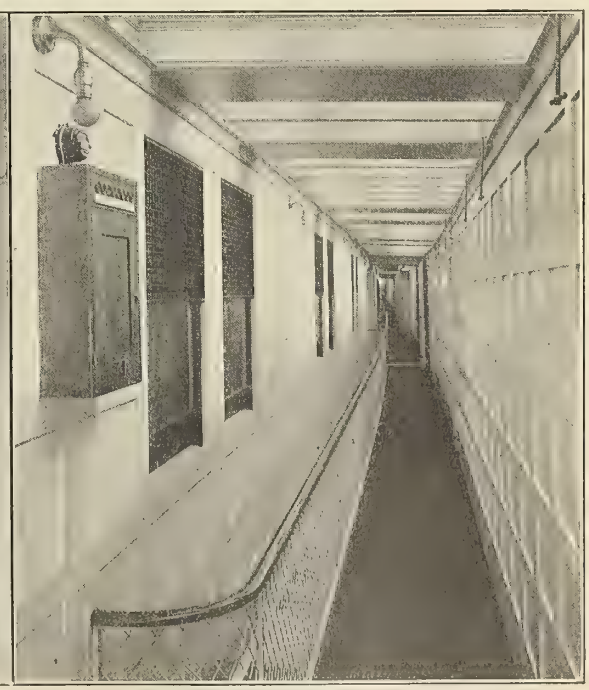


Fig. 6.—Sub-Station on the *See and Bee*

greater extent than was done on the *Washington Irving*. This was done by means of sub-stations which show the exact location of the fire, while the main stations in the engine room and pilot house show the general location, so that the engineer and captain are better prepared to give definite orders for fighting the fire. The main annunciators in the engine room and pilot house show immediately what deck the fire is on and whether forward or aft of amidships. The sub-stations, which are also in the form of annunciators, announce the exact location of the fire, so that those on duty at that station can immediately respond to orders without making the alarm general. In this way a fire may break out and be controlled without sounding a general alarm and without unnecessarily exciting the passengers on the ship.

Producer Gas Towboats

Low cost of operation is the main reason for using gas-producers in connection with marine or gasoline (petrol) engines. According to figures supplied by manufacturers of this type of machinery, units even smaller than 50 horsepower can develop one brake-horsepower on one pound of coal, while in an ordinary steam plant of the same horsepower from four to eight times as much coal per horsepower-hour is required. Furthermore, as in a producer-gas plant eight pounds of coal will do the work of a gallon of gasoline (petrol), it will be found that producer-gas coal at $5 (1/0/10) per ton will prove as cheap as gasoline (petrol) or other oil at two cents (1d.) a gallon. The cost of operating a producer-gas plant, therefore, is equivalent to buying coal for a small boiler plant as low as $1.25 (5/2½) a ton. Suitable fuel for marine gas producers can be bought in small quantities in New York at $4 (16/8) per ton, and in larger quanities at still lower figures.

In addition to its remarkable economy, the marine gas-producer weighs but from one-fourth to one-third as much as a Scotch marine boiler, and takes up only about one-third as much space as a watertube boiler. It also requires less help, as the coal is charged into the producer in large quantities in comparatively cool quarters at intervals of about four hours, whereas with a steam plant it is necessary to have stokers in constant attendance.

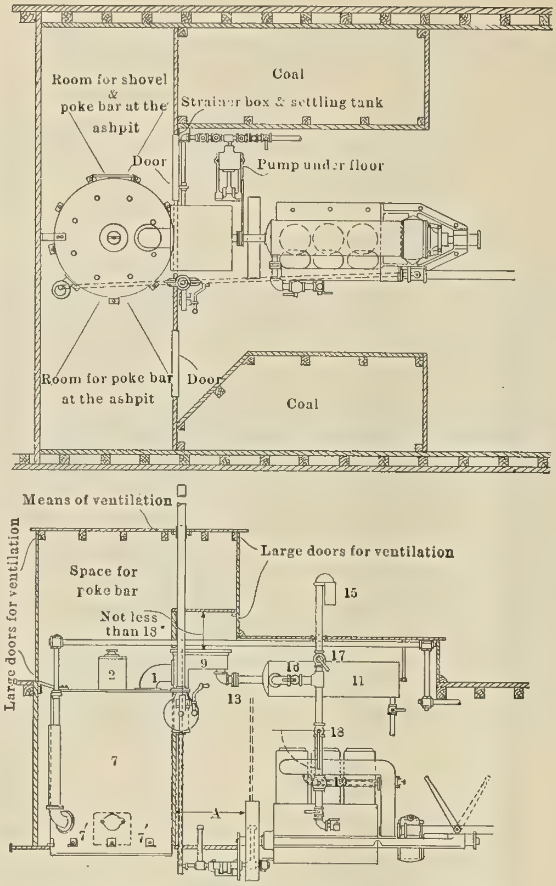


Fig. 2.—Typical Marine Gas-Producer Installation

In Fig. 2, which is a sketch of a typical marine gas-producer installation, 7 is the generator. This is simply a cylindrical shell resting on end and held down by means of the lugs 7'. In the bottom of this shell is an ash pit, above which is a shaking grate. The inside vertical walls are lined with brick. The smaller cylinder, 2, on top of the generator is the coal hopper, by means of which the generator is charged with coal or other solid fuel. The gas generated leaves by the pipe elbow, 1, on top, and goes to the scrubber, 9. As the gas is at this time hot and dusty, it is treated with water in the scrubber, where it is cooled, washed and dried. The gas is then ready for use, and goes through pipe, 13, to chamber, 11, and then through valve 16, and down to the engine. Air is drawn in through pipe, 15, the amount being controlled by the amount of opening to valve 17. The gas and air are then mixed, making an explosive mixture in pipe *T* below 17; 18 is the throttle valve and 19 the intake manifold of the engine.

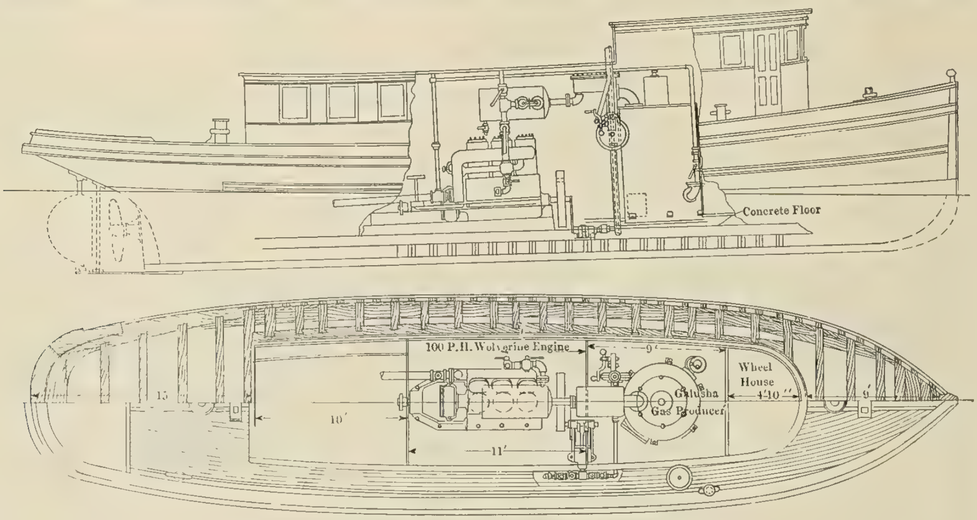


Fig. 1.—General Arrangement of Towboat *Webb*

Fig. 1 shows the general arrangement of the towboat *Webb*, 63 feet long over all, 14 feet 4 inches beam and 7 feet depth, equipped with a 100-horsepower marine gas-producer and engine. The coal consumption of this plant is only 100 pounds per hour. It is the third producer-gas towboat placed in operation by one concern within eighteen months.

Wolverine IV is a steel towboat 50 feet long by 11 feet 3 inches beam, and 5 feet 3 inches draft, owned by the American Fruit & S. S. Company, of New Orleans, La. This boat has been in active operation since 1910. The power equipment consists of a 75-horsepower engine and producer. According to the owners, the power plant works with the utmost regularity and with minimum attention. The boat is used on long hauls of several days' duration with the engine running full power practically all the time. The consumption of anthracite coal, about ⅜ inch to ½ inch in size, including the stand-over consumption at night, varies from 600 to 704 pounds per twenty-four hours when the boat is in operation ten to twelve hours per day. The engine can be run dead slow or at any intermediate speeds up to about 300 revolutions per minute without any tendency to stop or without disengaging the clutch. As a consequence of the satisfactory results obtained with *Wolverine IV*, the American Fruit & S. S. Company have added half a dozen producer-gas propelled boats to their fleet during the past year.

What is probably the smallest producer-gas towboat is the shallow-draft tunnel stern boat *Wolverine I*. The boat is 32 feet long and has a draft of about 18 inches. The gas-producer and engine are of 18 horsepower.

Another shallow-draft, semi-tunnel stern boat, although of a somewhat larger size, is the *Teddy*. The boat is in use night and day and covers a course of 226 miles each way. The 40-horsepower gas-producer installed is in charge of Mexicans, half Indian, and in operation consumes 39 pounds of charcoal per hour. This fuel is said to give almost no ash and to produce an excellent grade of gas for the engine.

Fig. 3.—Towboat *Dawn* Fitted with 100-Horsepower Wolverine-Galusha Power Plant

The towboat *Dawn*, shown in Fig. 3, which is owned by Locke, Moore & Co., Ltd., is 64 feet long, 14 feet beam and 6 feet deep, equipped with a 100-horsepower gas-producer plant. The boat is engaged in towing logs down the Calcasieu River, a distance of about thirty-five miles. Forty hours are required to make the trip, bringing down an average load of 2,000 logs. According to the owners, the consumption of coal is 100 pounds per hour, or 4,000 pounds for the trip, costing $16.50 (3/8/9), or 44¼ cents (1/10⅛) per hour. If the engine is run on gasoline (petrol) instead of producer-gas, it burns twenty gallons of gasoline (petrol) per hour, or 800 gallons on the same trip, costing $96 (20/0/0) for the trip, or $2.40 (10/0) an hour. Boats of the same power engaged in the same work, equipped with a steam plant burning wood as fuel, cost about 75 cents (3/1½) an hour for fuel, in spite of the fact that wood is the cheapest fuel to be had in that locality. In other words, the steam-tug fuel bill is 80 percent greater than that of the producer-gas tug. In addition to this, the steam tugs are obliged to have an additional man on board as fireman, costing $2 (8/4) per day.

Fig. 4.—Towboat *Dart*, Fitted with 50-Horsepower Wolverine-Galusha Power Plant

Another producer-gas towboat, named the *Dart*, a view of which is shown in Fig. 4, has been engaged in general towing for a couple of years. Its owners report that the boat operates on approximately 50 pounds of coal per hour. If operated on gasoline (petrol) instead of coal it consumes approximately 15 gallons of gasoline (petrol) per hour. As coal costs the owners $8.25 (1/14/4½) per ton, and gasoline (petrol) 12 cents (0/6) per gallon, it will be seen that the comparative fuel costs per hour are 20½ cents (0/10¼) for producer-gas, as against $1.80 (7/6) for gasoline (petrol).

A striking illustration of the difference in fuel cost was made by towing a single barge, light, with this boat a distance of 90 miles, using gasoline (petrol) as fuel and making the same trip again under identical conditions, but using producer-gas as fuel. With gasoline (petrol) it took twenty hours to make the trip and 300 gallons of gasoline (petrol) were burned, which, at 15 cents (0/7½) per gallon, made the total fuel cost $45 (9/7/6). On producer-gas it required twenty-one hours to make the trip, and 1,050 pounds of coal were burned, which, at $8.25 (1/14/4½) a ton, made the total fuel cost $4.33 (18/0), a difference in favor of the gas-producer as compared with gasoline (petrol) of $40.70 (8/9/7) in a twenty-hour run.

The gas-producers installed on the boats mentioned above were built by A. L. Galusha & Co., Boston, Mass., while the engines were of the Wolverine make, manufactured by the Wolverine Motor Works, Bridgeport, Conn.

Monthly Shipbuilding Returns.—The Bureau of Navigation, Department of Commerce, reports 120 sailing, steam and unrigged vessels of 17,849 gross tons built in the United States and officially numbered during the month of July. Four steel steamships, aggregating 6,377 gross tons, were built on the Atlantic coast and 6 steel steamships, aggregating 2,082 gross tons, were built on the Great Lakes.

New Mallory Line Freight Ships

Two Single-Screw Freight Steamers of 6,600 Tons Deadweight Capacity and 14 Knots Speed Built at Newport News

Two new freight ships, the *Neches* and *Medina,* of 6,600 tons dead-weight capacity each, have just been completed by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Mallory Steamship Company, New York. The *Neches* has just completed her six-hour endurance trial, and reached New York August 21 on her maiden trip. The *Medina* will undergo trials this month.

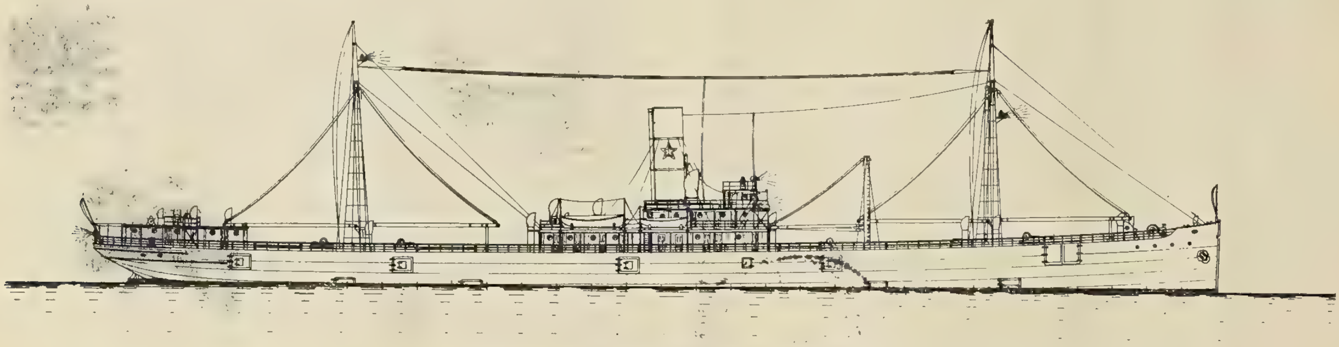


Fig. 1.—Outboard Profile of the *Neches*

The new ships were designed by Theodore E. Ferris, naval architect and marine engineer, New York, from lines laid down by H. H. Raymond, vice-president and general manager of the Mallory Steamship Company. With a cubic capacity of 350,000 cubic feet, a dead-weight cargo capacity of 6,600 tons and a designed speed of 14 knots, they are among the most modern and largest freight steamships operating on the Atlantic coast. A most complete equipment for rapid loading and discharging cargo has been provided, consisting of nine cargo ports with clear openings of about 8 feet by 6 feet on each side of the 'tween decks, a large over-all hatch forward and four additional cargo hatches, the largest of which is 24 feet by 15 feet, together with six double-drum, quick-acting hoisting winches, ten 8-ton cargo booms and one 30-ton cargo derrick with a compound, double-drive winch.

The *Neches* and *Medina* are of the hurricane-deck type, having a complete steel hurricane deck, main deck and lower deck. They are 421 feet long on deck, 405 feet long between perpendiculars, 54 feet 3 inches beam, 35 feet 9 inches molded depth to the hurricane deck, with a load draft of 24 feet. There are five transverse watertight bulkheads forming three cargo holds and 'tween-deck cargo spaces. The cargo holds and 'tween decks

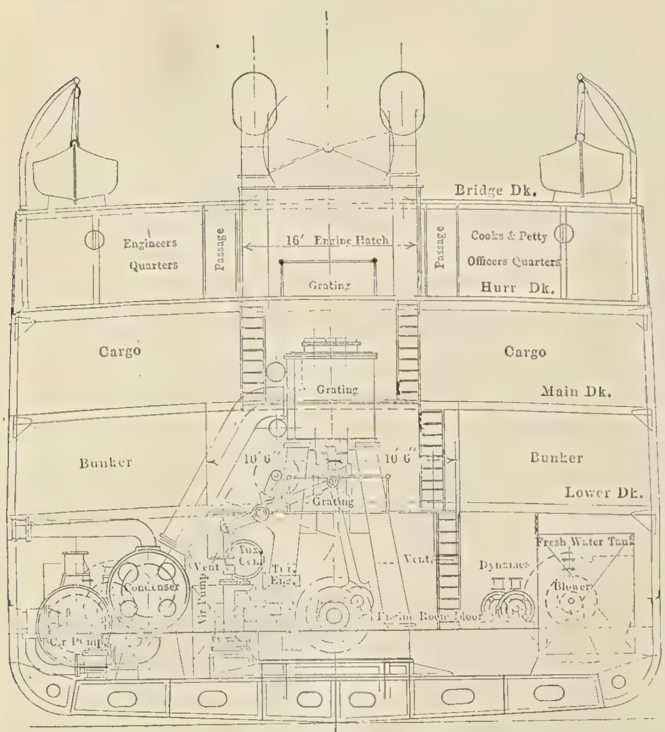


Fig. 2.—Section Through Engine Room

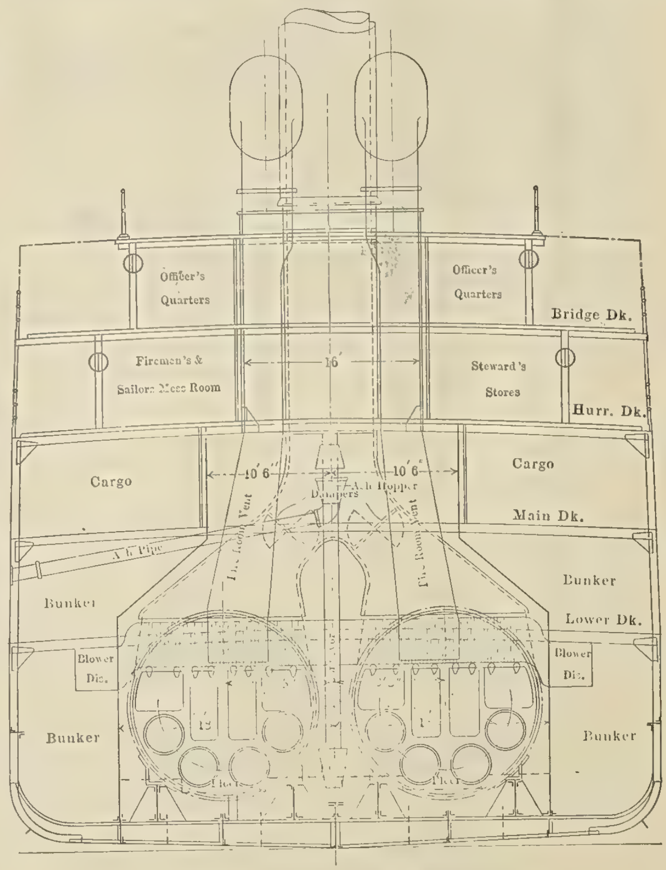
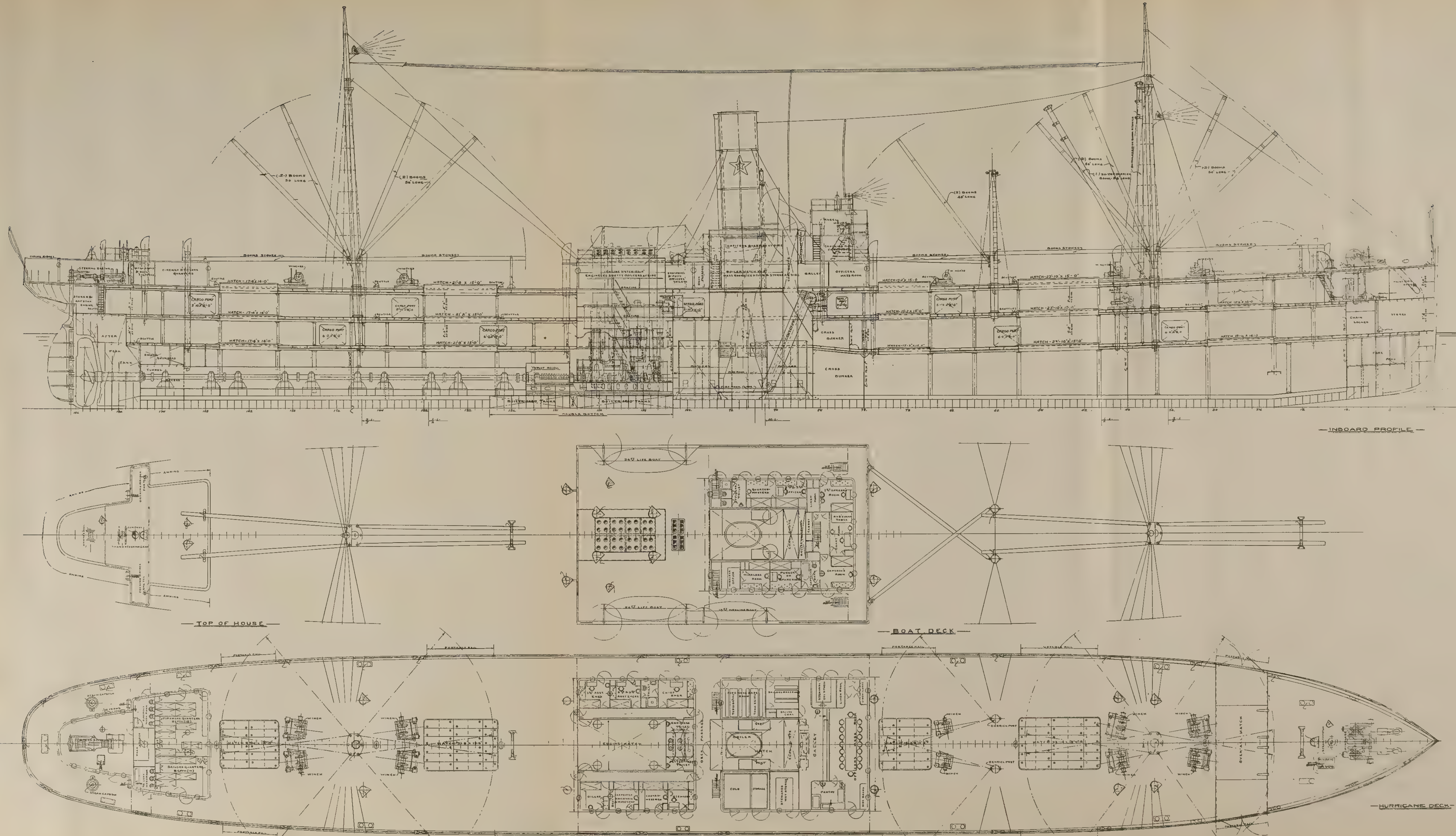
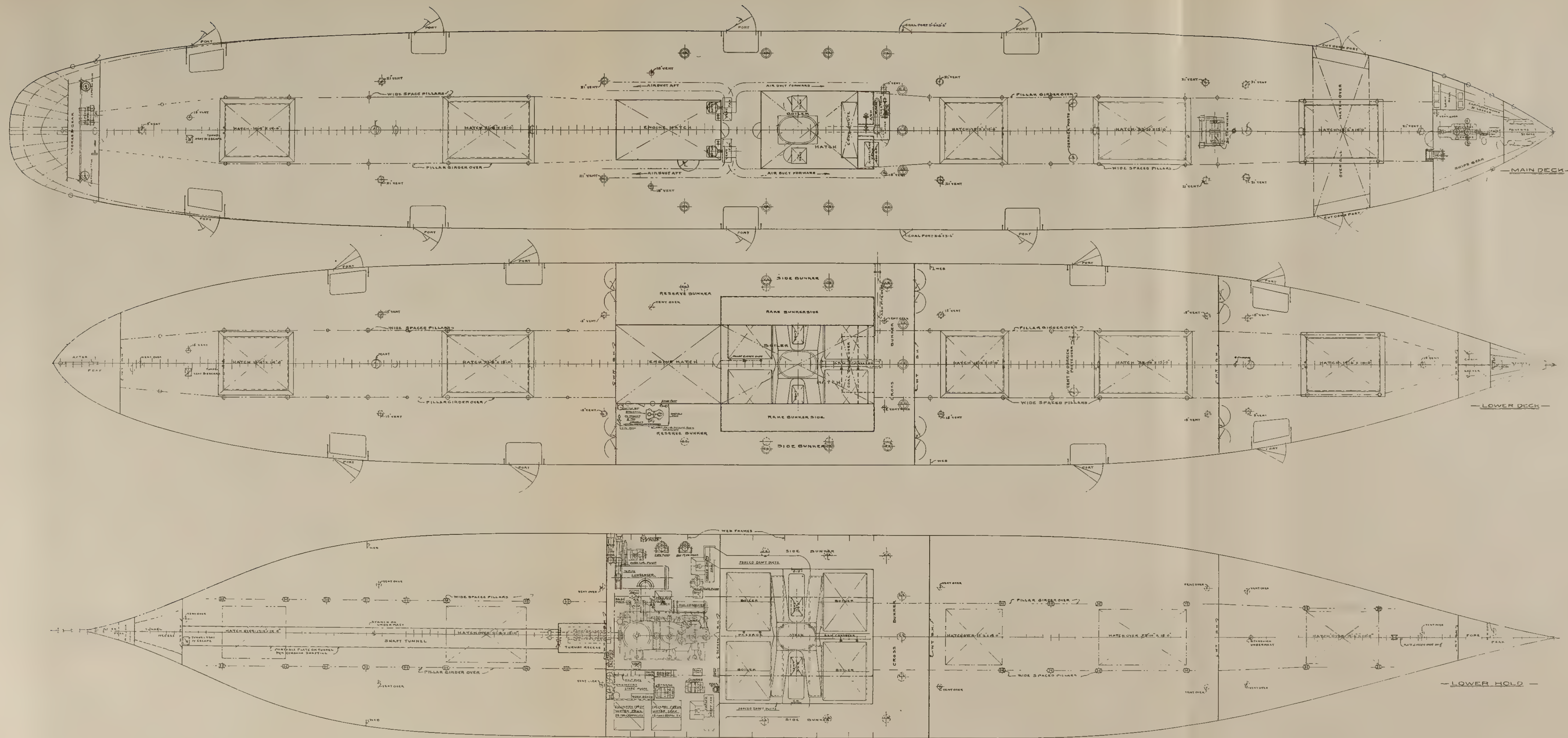


Fig. 3.—Section Through Boiler Room



INBOARD PROFILE, BOAT AND HURRICANE DECK PLANS OF THE MALLORY LINE FREIGHT STEAMSHIPS NECHES AND MEDINA

PLATE I



PLANS OF THE MAIN AND LOWER DECKS AND LOWER HOLD OF THE MALLORY LINE
FREIGHT STEAMSHIPS NECHES AND MEDINA

Plate II

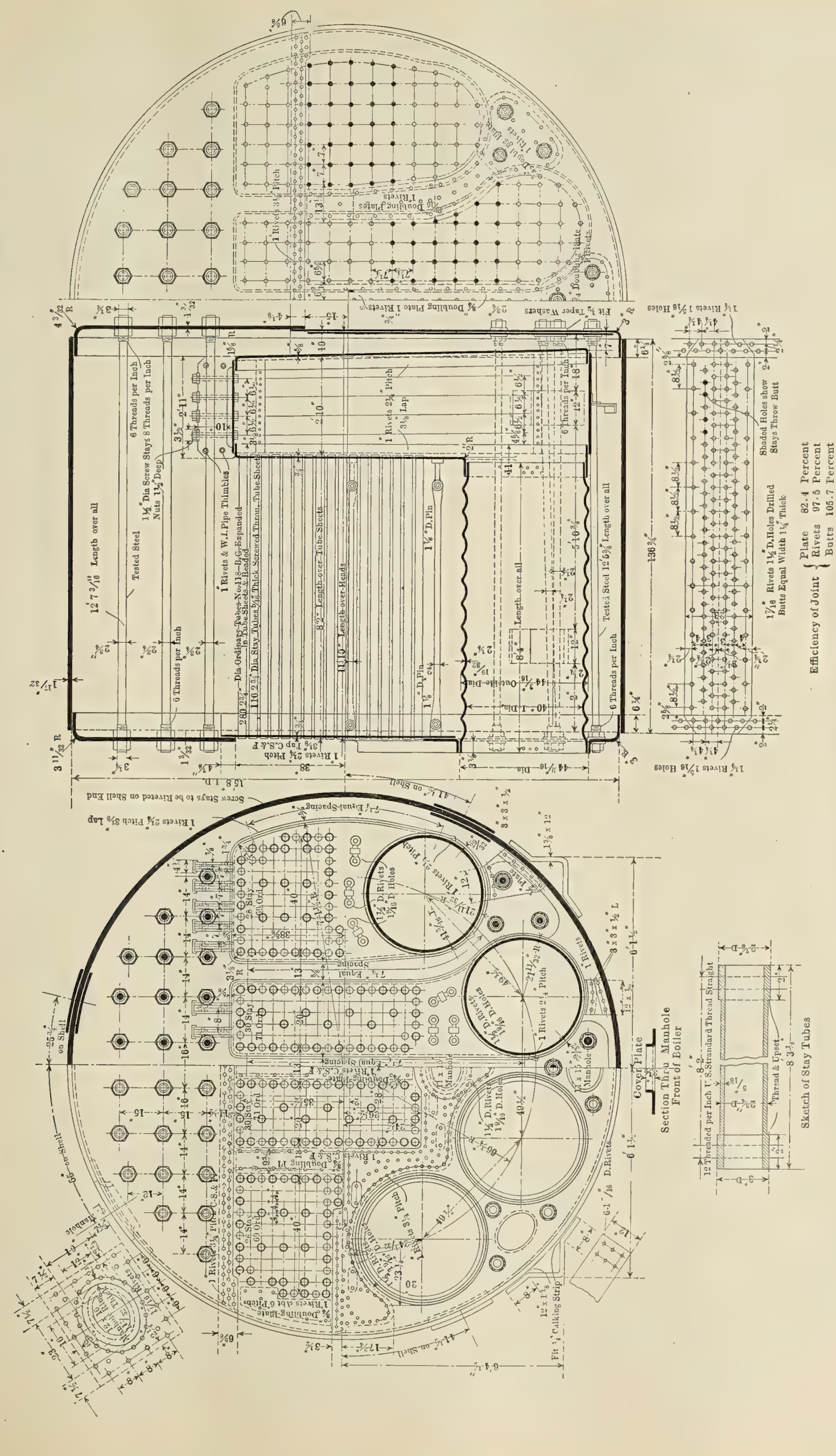


Fig. 4.—Detail Plans of Boilers for the *Neches* and *Medina*

are amply ventilated for the transportation of perishable cargo by large ventilators and cowls at the weather decks, and, in addition, the upper 'tween decks are mechanically ventilated by air ducts and electrically operated fans. Two direct-connected motors and fans in the engine-room casing discharge into one common duct led into the smoke-stack. This system of mechanical ventilation is provided for transporting onion cargoes and other similar commodities and further to provide against excessive temperature. The hurricane deck, in addition to being a complete steel deck, is sheathed with wood-calked decks for insulating purposes.

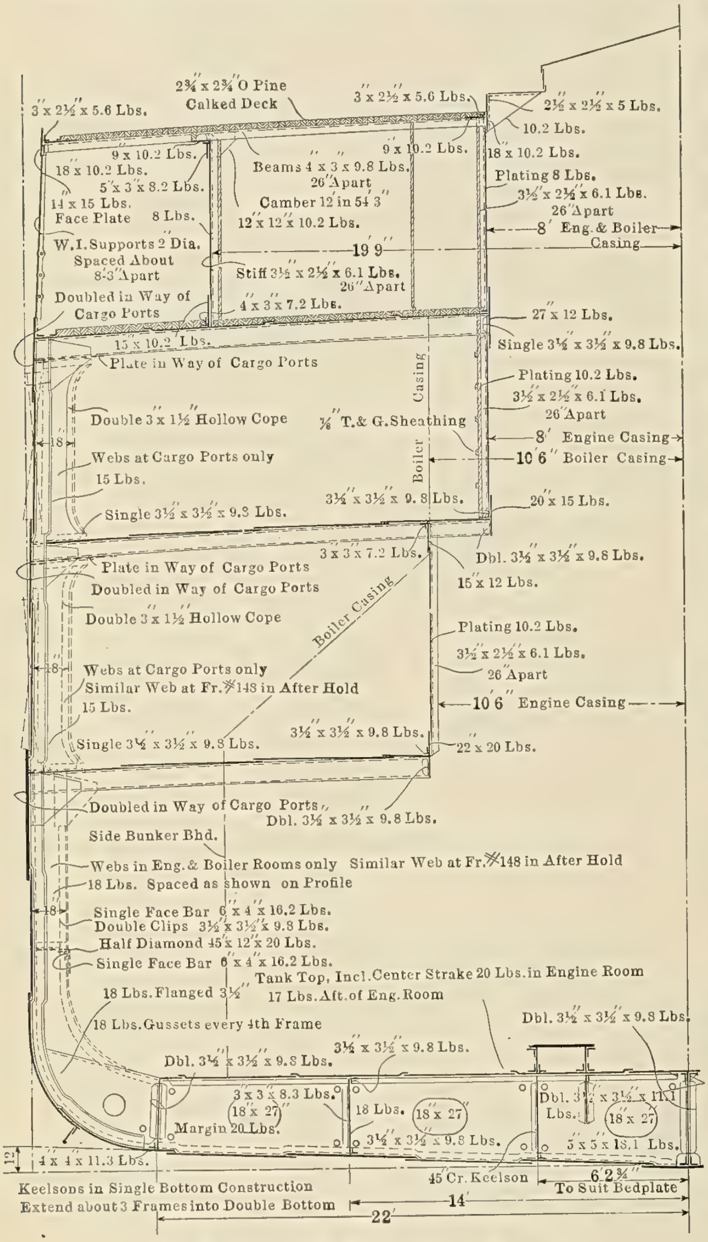


Fig. 5.—Section in Way of Engine Room

Accommodations

Amidships, on the hurricane deck, steel deck-houses are erected providing space for cold-storage rooms, galley, pantry and separate messrooms for the officers, firemen and sailors, a steward's storeroom, quarters for the engineers, steward, cooks, messmen, carpenter, boatswain, watchmen, oilers', petty officers' and engineers' washrooms. In a steel deck-house above are provided rooms for the capatin, the first, second and third officers, quartermasters, pursers and wireless operators. Above this house are the wheel-house and navigating bridge. Aft, on the hurricane deck, is a steel house for the firemen's and sailors' quarters, and also space for the steering engine, above which is a docking bridge.

Hull Construction

The hull has a straight stem and elliptical stern, two steel masts and two derrick hoists. In way of the machinery space and 26 feet aft of the engine room, a double bottom is fitted in which the feed-water is carried. The double bottom is built on the cellular system, with floors on every frame and two intercostal keelsons of 18-pound plate on each side. It is divided into two compartments on each side of the vessel with a drainage well across at the end of the engine room. The center vertical keel is continuous between peaks and intercostal for a distance of three frame spaces in the peak. Outside the double bottom the vertical keel is fitted with a rider plate. The two keelsons on each side of the center keel consist of continuous double angles on top of the floors, with intercostal plates. Side stringers consisting of a continuous angle and an intercostal plate are fitted in the hold. These are increased to the width of the web frames in the machinery space.

The frames, spaced 26 inches apart throughout, are 6-inch by 3½-inch by 13.5-pound angles in the peaks, extending from the center line to the hurricane deck and cut at the water-tight flats. For about three-fifths the length amidships, depending on the shape of the lines, the frames are 3½-inch by 3½-inch by 9.8-pound angles, with 7-inch by 3.45-inch by 3.45-inch by 20.9-pound channels around the bilge, and extending to the hurricane deck on every frame. Beyond three-fifths of the length amidships to the peak bulkheads the channels will extend down to the side line at the keel. In the double bottom the frames are 3½-inch by 3½-inch by 9.8-pound angles; 3½-inch by 3½-inch by 9.8-pound angle reverse frames are fitted in the forepeak, extending to the hurricane deck on every frame. Similar reverse frames, extending to the main and hurricane decks alternately, are fitted in the after peak. Reverse frames of the same size are fitted across the top of the floors in way of channel frames. These are double in the boiler room and also in the double bottom under the main engine only, elsewhere they are single. The floors are 30 inches by 20 pounds for half length amidships, reduced to 15 pounds at the ends. In the boiler room the floors are 30 inches by 23 pounds, and in the double bottom 45 inches by 18 pounds.

Deck beams are fitted on alternate frames in both the lower and hurricane decks, while on the main deck beams are fitted on every frame, the scantlings of which are shown on the midship section.

The side plating of scantlings shown in the midship section are worked in in-and-out strakes with overlap butts throughout. Doubling plates are fitted at all cargo ports.

Five water-tight bulkheads extend to the main deck, while non-water-tight bulkheads are fitted between the main and hurricane decks fore and aft of the machinery space and in the lower 'tween decks between the engine and boiler rooms. The lower half of the bulkheads to the lower deck are of 14-pound plate, and the upper half between the lower and main decks of 12-pound plate. Between the main and hurricane decks the bulkheads are of 10.2-pound plate. Vertical stiffeners consisting of 6-inch by 3½-inch by 3½-inch by 15.2-pound channels bracketed both top and bottom and spaced 30 inches apart, are fitted below the lower deck. Between the lower and main decks, 5-inch by 3-inch by 9.8-pound angle stiffeners are fitted,

while between the main and hurricane decks the stiffeners are reduced to 3½-inch by 3½-inch by 6.6-pound angles. Special stiffening is introduced on the peak bulkheads.

An ash bunker is built of plates, and angles on the main deck over the forward battery of boilers, and contains the ash-hoisting engine and gear. Fresh water is carried in

The boiler shells are 1 17/32 inch thick, the upper heads 1 5/32 inch thick, and the tube sheets ¾ inch thick. The tubes, of which there are 396 to each boiler, are 2¾ inches outside diameter and 8 feet ½ inch long between tube sheets. The furnaces are 40 inches diameter, with grates 5 feet 6 inches long.

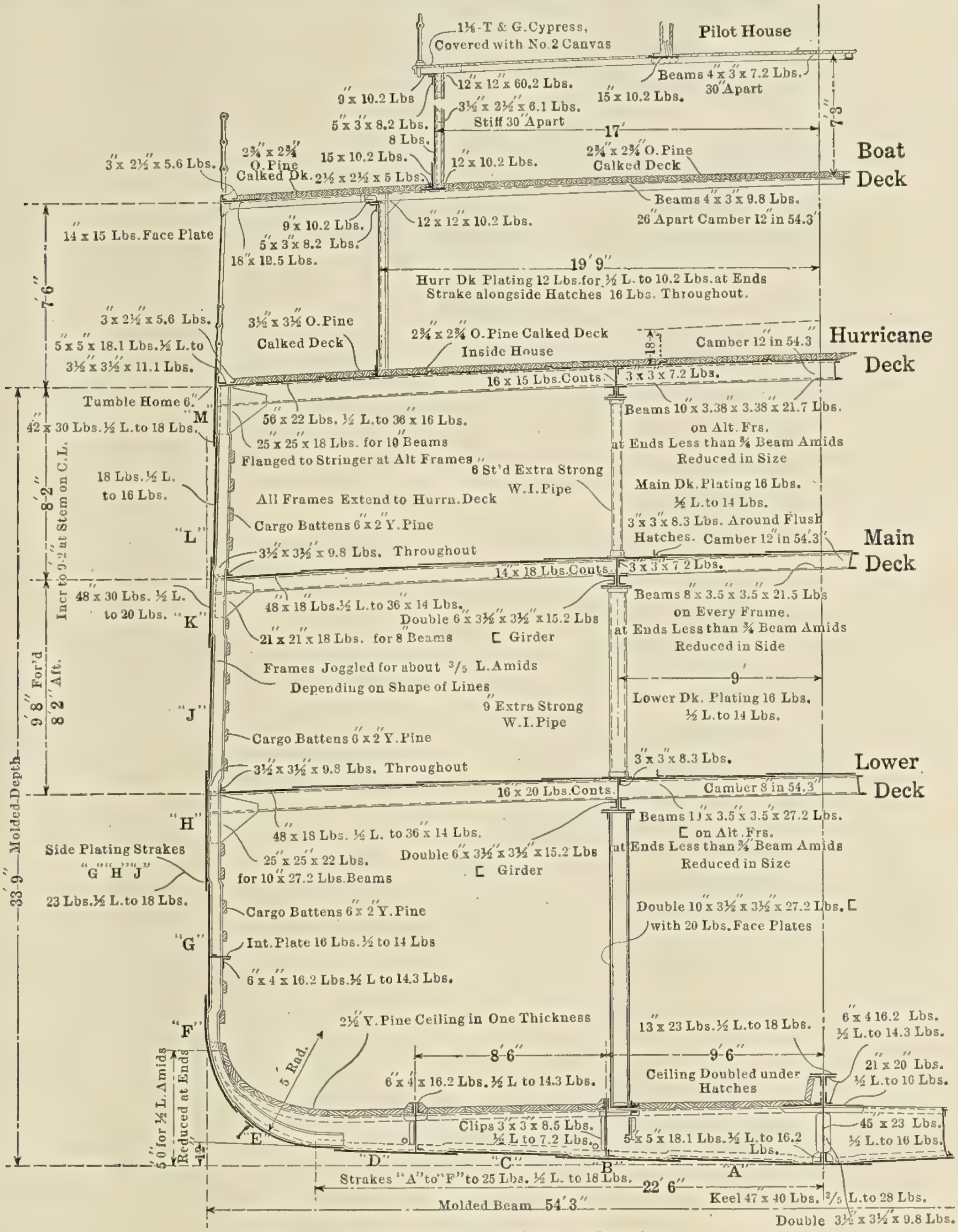


Fig. 6.—Midship Section, Showing Scantlings

two tanks with a total capacity of 30 tons, located on the starboard side of the main engine room.

Boilers

Steam is supplied at 200 pounds per square inch working pressure by four four-furnace Scotch boilers, 15 feet 8 inches inside diameter and 12 feet long over heads, fitted with heated forced draft. Each boiler has 2,843 square feet of heating surface distributed as follows: Tubes, 2,293 square feet; furnace, 222 square feet; combustion chambers, 328 square feet. The grate area of each boiler is 73.5 square feet, making a ratio of heating surface to grate area of 38.8 to 1. The boilers are designed to evaporate 235 pounds of water per square foot of grate area, or 17,270 pounds per hour per boiler.

The forced-draft equipment consists of two Sturtevant multi-vane fans located in the engine room, driven by vertical 6-inch by 5-inch blower engines. The fan-wheels are 3 feet 4¾ inches diameter, and are designed to maintain a combustion of 25 pounds of coal per square foot of grate, creating a pressure of at least 1½ inches of water at the boiler furnaces. The air is drawn from the fire rooms.

The ash-handling gear consists of an endless-chain conveyor with a sheet-iron casing, dumping the ashes into a hopper on the main deck.

Main Engines

Propulsion is by a single screw of the solid type, 17 feet 3 inches diameter and 19 feet 9 inches pitch, made of

manganese bronze, actuated by a triple-expansion engine of 4,100 indicated horsepower, with cylinders 29 inches, 49 inches and 84 inches diameter, with a common stroke of 54 inches operating at 85 revolutions per minute. The high and intermediate-pressure valves are of the piston type, while the low-pressure cylinder is fitted with a double-ported slide valve. The valve gear is of the Stephenson double-bar link type. The main air and two bilge pumps are worked off the main engine.

The crank and thrust shafts are 16½ inches diameter, the line shaft 15⅜ inches diameter, and the tail shaft 17¼ inches diameter and 19 inches over the sleeve. Water service taken from the sea is provided for the main bearings, crank-pins and thrust and steady bearings. Cooling water for circulating through the guides and for spraying the crosshead-pins is taken from the sanitary service, the water being retuned to the sanitary service.

Auxiliaries

The main condenser is independent, of circular section, with cast-iron shell and a cooling surface of 6,800 square feet. The auxiliary condenser is of similar type, with 800 square feet of cooling surface. The main air pump is of the Edwards type, 30 inches by 24 inches, attached to the main engine. The auxiliary air pump is of the horizontal combined Blake type 10 inches by 12 inches by 12 inches by 12 inches. The main circulating pump, which has a 42-inch diameter runner and 17-inch pipe, is driven by a 9-inch by 10-inch engine. The auxiliary circulating pump is a horizontal combined Blake pump, 10 inches by 12 inches by 12 inches by 12 inches. Two bilge pumps, 7 inches and 5½ inches diameter by 24-inch stroke, of the plunger type, are attached to the main engine.

The other auxiliary pumps, located in the engine room, include a vertical duplex Blake main feed pump, 12 inches by 8½ inches by 12 inches, and a duplicate auxiliary feed pump; a vertical duplex Blake fire and bilge pump, 12 inches by 8½ inches by 12 inches; a vertical simplex Blake sanitary pump, 6 inches by 12 inches by 6 inches and a vertical simplex Blake fresh-water pump, 4½ inches by 6 inches by 6 inches. The main feed pump draws from a feed-water filter tank of 1,400 gallons capacity in the engine room and the fresh-water manifold and discharges either through the feed-water heater or direct to the boilers.

An electric plant is provided consisting of two 10-kilowatt turbo-generators supplied by the Terry Steam Turbine Company. The feed-water heater is of the Reilly Admiralty type, and there is also a 2-ton capacity Brunswick direct-expansion ice machine for cooling the steward's cold-storage boxes, which have a cubic capacity of 783 cubic feet.

Deck Auxiliaries

The ships are equipped with a Hyde steam windlass and steam capstans of the Hyde make, the windlass being

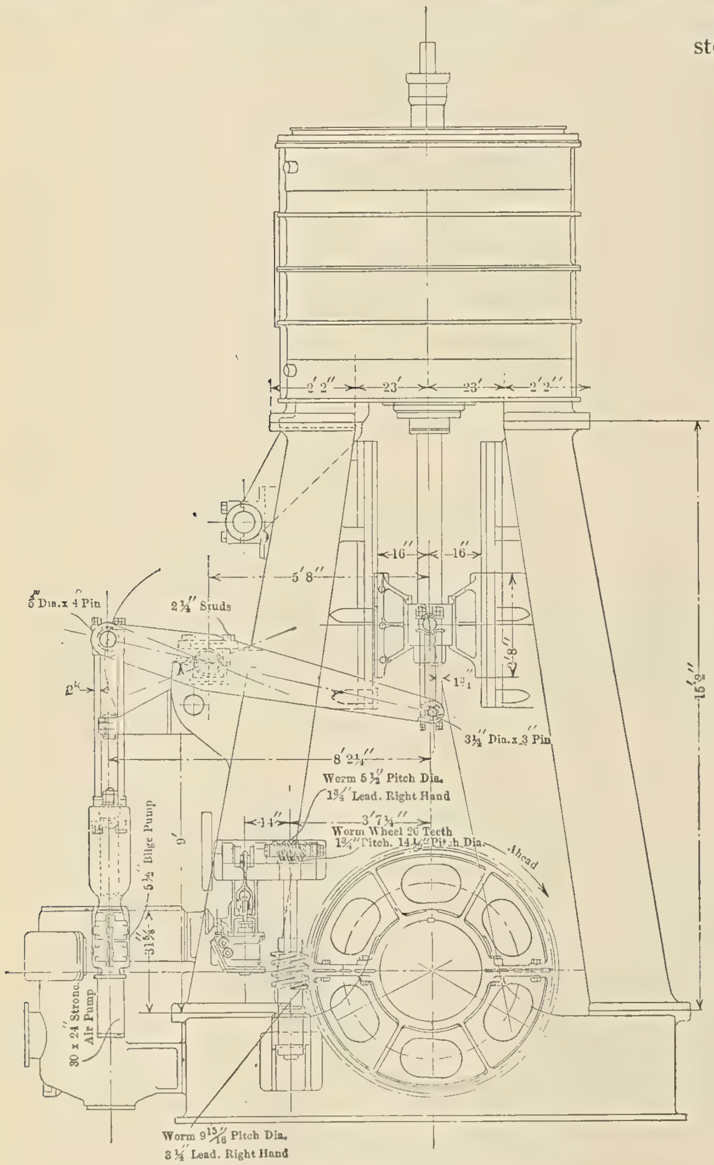


Fig. 7.—After End Elevation of Engine

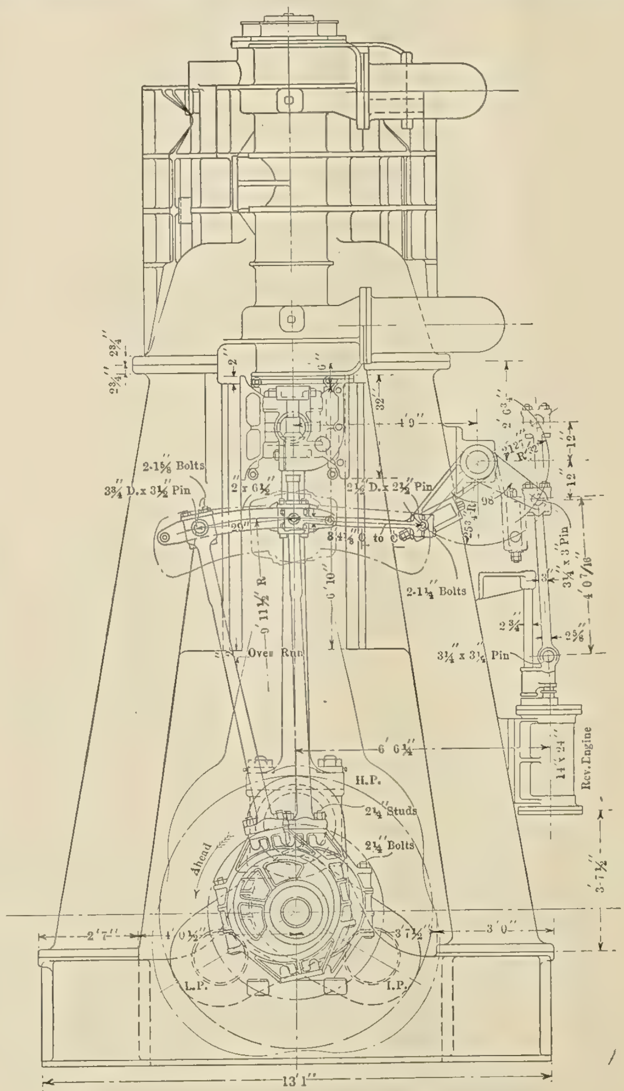


Fig. 8.—Forward End Elevation of Engine

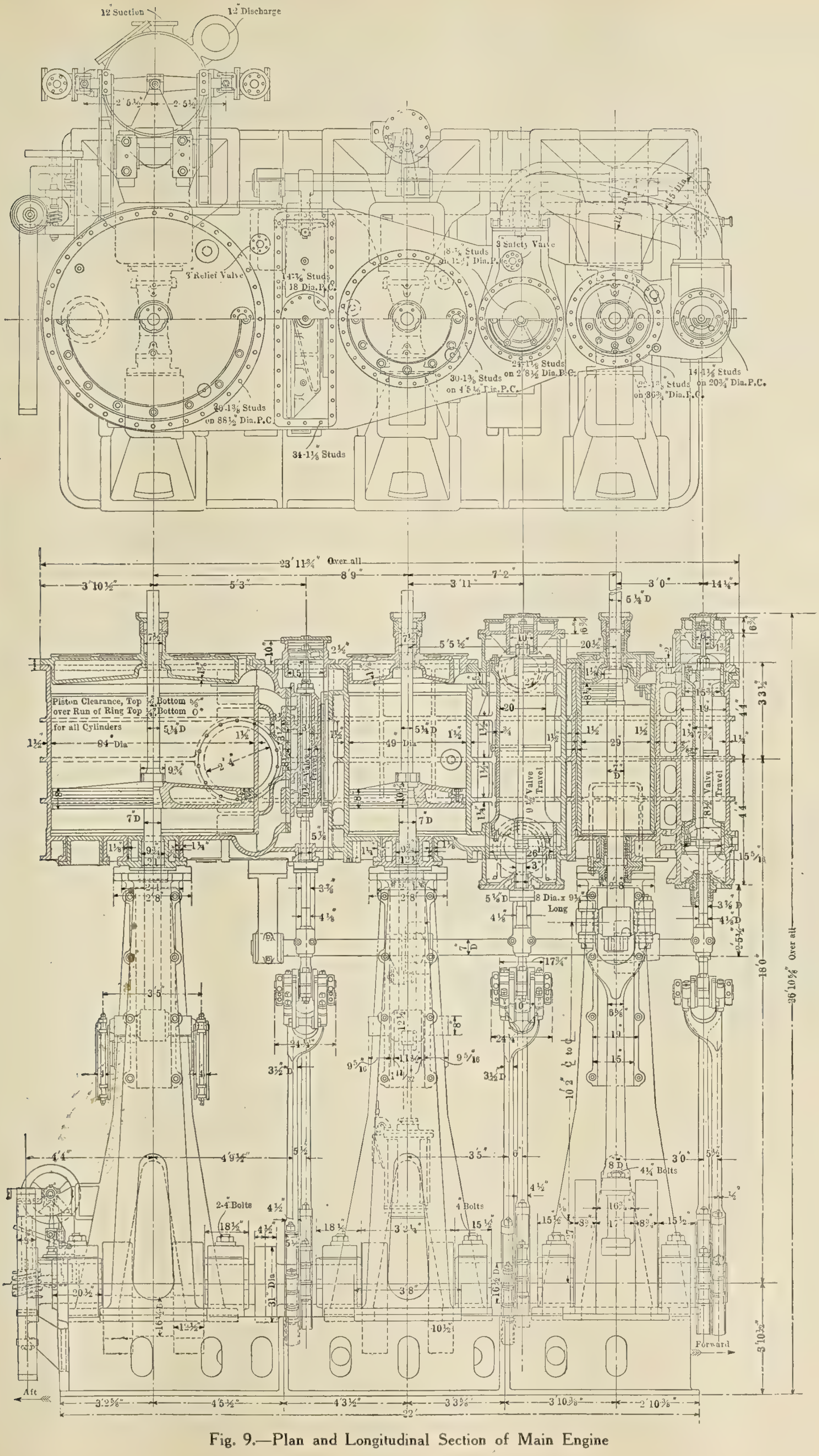


Fig. 9.—Plan and Longitudinal Section of Main Engine

driven by a 12-inch by 12-inch engine and the capstans by 8-inch by 8-inch engines. The equipment of winches for handling freight is very complete, there being six double-drum, quick-acting hoisting winches, all of the Williamson make. Four winches, with cylinders 8 inches by 8 inches, are for the 8-ton cargo booms, and two with cylinders 7 inches by 7 inches for the 3-ton booms. For the 30-ton derrick there is one compound type, double-drum Williamson winch, with cylinders 10 inches by 12 inches.

Both hand and steam steering gear of the Williamson make are fitted, the steam gear being operated by telemotor control from the wheel house. The steam steering engine, which is direct connected at the rudder stock with right- and left-hand screw, is 9 inches by 9 inches.

In addition to the complete electric lighting and steam-heating equipment, the vessels are fitted with wireless apparatus, submarine bells, electric fog whistles and complete navigating outfits.

Bolinder's Direct Reversible Marine Oil Engine

The construction details and method of operation, showing simplicity, reliability and accuracy of workmanship, together with the performance of the engine in actual installation, show why the Bolinder's engine has influenced the modern movement toward hot-bulb, or semi-Diesel, engines and inspired their wide adoption.

The Bolinder's engine is built by the Bolinder's Company, at Stockholm, Sweden, and by the Bolinder's Company, New York, 30 Church street, New York City. In producing these engines there are parts which are finished to half a hundredth of a millimeter (1/5,000th of an inch). This remarkable standard of accuracy is required for fuel-pump barrels and rams, while in the other details of the engine the accuracy is of the order associated with Diesel motor construction, and grinding is extensively used. All this wonderful accuracy does not improve the heat efficiency or mechanical efficiency to any appreciable extent, but in conjunction with the selected materials it gives to the engines a durability that ensures the maintenance of the initial efficiency at a minimum running expense. An outline of the cycle of operations will, however, show the possibilities of heat efficiency and economy of operation.

Fig. 1.—Towboat *Marie L. Hanlon*, Fitted with 160-Horse-power Bolinder Engine

The Bolinder's crude-oil engine is of the modern two-cycle type, delivering a power impulse for each revolution of the crank. It has no valves, cams, gears or electric-sparking device and the construction is such that all parts work automatically and cannot be thrown out of adjustment. On the upstroke of the piston *A*, Fig. 2, a partial vacuum is created in the enclosed crank case *C*, causing the necessary charge of air to rush in at the two opposite inlets *B*. Near the end of the upstroke an oil pump automatically injects the proper amount of oil through the nozzle *F* into the ignitor ball *E*. The latter has been previously heated to a dull red heat by a blow-lamp, so that the hot walls of the same immediately convert the oil into a vapor which mixes with the air compressed in the cylinder and ignites. This creates pressure, driving the piston downward, and during the down-stroke the air, previously drawn into the crank-case, is compressed.

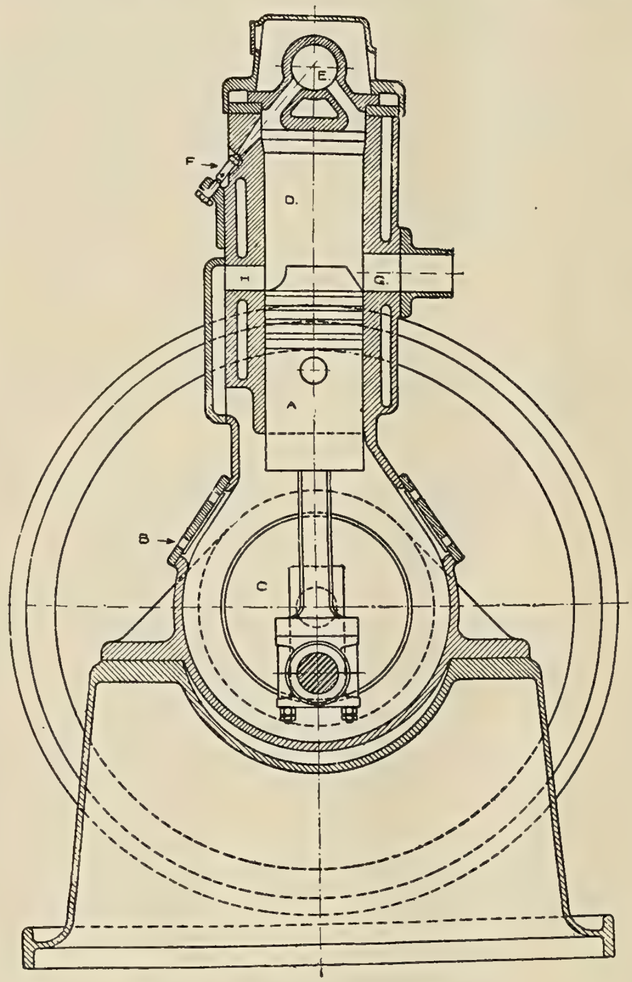


Fig. 2.—Section of Bolinder Engine

When the piston approaches the end of the down-stroke it uncovers the exhaust port *G*, permitting the burnt gases to escape through the port to the silencer, so that the pressure approaches that of the atmosphere. Immediately after port *G* is opened the transfer port *H*, on the opposite side of the cylinder, is uncovered by the piston, allowing the charge of compressed air in the crank-case to rush into the cylinder, where it is deflected upward by the baffle-plate shape of the top of the piston, thereby scavenging the cylinder of exhaust gases and filling it with air close to atmospheric pressure, which is again compressed on the upstroke of the piston. Due to the two ports of the ignitor ball *E*, the ball is thoroughly cleaned of all deposit by means of the fresh air rushing through it. This is a decided advantage, ensuring powerful ignition and doing away with excessive carbon deposit.

The cycle of operations such as outlined is common to

all two-cycle types of engines, and while the Bolinder engine embodies many distinctive features of simplicity and reliability, it is chiefly due to the fuel feeding and reversing mechanism that attention has to be drawn, for these have contributed greatly to its commercial and engineering success. For each cylinder there is a separate main fuel pump, which in single-cylinder engines is mounted on the after end of the engine, a similar position being occupied by the brace of main fuel pumps for a double-cylinder set, while in a four-cylinder motor the main fuel pumps are fitted in pairs at the forward and after ends of the engine. An auxiliary fuel pump for reversing is combined with each main fuel pump group. The principal parts of the fuel-pump mechanism are: A crescent-shaped rocker bearing at each end a point to strike the rams of the fuel pumps, one horizontal and one vertical; a "T"-shaped pump casting, between which and the crescent-shaped rocker is a bell crank with faced ends. This gear is mounted directly to a bracket supported on the after end of the cylinder jacket in such a manner that the whole can be swung through a small arc in a vertical plane. The crescent rocker receives motion from an eccentric rod driven by the crank-shaft, and provides for the actuation of whichever fuel pump may be in service.

When the motor is running in the direction for ahead propulsion the bell crank that selects the appropriate fuel pump rests with its horizontal arm upon a stop while the downward or vertical arm lies with its faced end so far to the right that the adjoining point on the end of the crescent rocker is moved off the line of the vertical fuel pump. It is the horizontal fuel pump that feeds the injections to the motor, subject to governing. To reverse the direction of running, a handle at the side of the engine is drawn astern, which has the effect of moving in a transverse direction the rod that is pinned to the bell crank, and at the lower end of which is a rhomboidal link surrounding a friction disk on the shaft. If the rotation be for ahead the link will be resting with its "right-hand" side against the friction disk, the motion, therefore, tending to keep it down so that the horizontal arm of the bell crank is held down on the stop, as already mentioned. On drawing the reversing lever astern, the link is pulled over until its "left-hand" side is against the friction disk, causing a lifting effect on the rod and tilting the bell crank upwards so that the horizontal pump is thrown out and the vertical one thrown in. This allows the crescent rocker to give the vertical fuel pump an impulse on the compression stroke, delivering the oil into the hot bulb during that stroke and causing combustion to occur before the piston reaches the upper dead center. This reverses the direction of rotation and the friction which gave the bell crank an upward motion or lift will have its direction reversed with the opposite rotation and cause a downward motion to the bell crank, throwing out the vertical and throwing in the horizontal pump. Thus it is seen that the auxiliary pump is used only for reversing, and that reversing may be done either way by the same or analogous method.

Fig. 1 illustrates the *Marie L. Hanlon*, a tow-boat, which lately went into commission on San Francisco Bay, and is fitted with a two-cycle, two-cylinder Bolinder engine of 160 brake horsepower, at 225 revolutions per minute. The hull of this vessel is 71 feet 9 inches long by 17 feet 9 inches beam by 8 feet 6 inches draft. The engine was tried on California oil before it was installed in the vessel, and it was found that the machinery functioned satisfactorily on crude oil provided the oil was well filtered and heated to about 100 degrees before injection. The engine was found to operate perfectly on "Diesel engine" oil, a residue product of the asphalt refineries, without any preheating or extra filtering of any kind. On a trial trip the engine was run on a governor at a rate which developed 125 horsepower. No attempt was made to force the vessel, but the average of several runs over the measured mile course gave an average speed of 11.28 miles per hour. While no attempt was made on this trip to obtain accurate data on fuel consumption, it is estimated at about 140 gallons, at 2.4 cents per gallon, for a day of ten hours.

The Talbot Marine Watertube Boiler

An oil-fired watertube boiler of exceptionally small size and weight per horsepower, for which remarkably high thermal efficiency is claimed, has been placed on the market by the Talbot Boiler Company of New York. The weight of a 100-horsepower boiler of this type, including all accessories, is only 5,000 pounds, or 50 pounds per

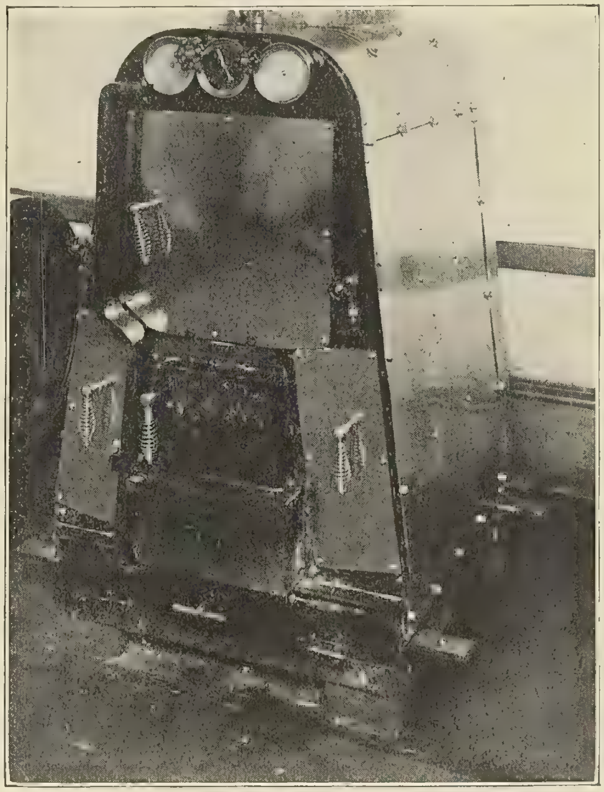


Fig. 1.—Talbot Watertube Boiler

horsepower, while the floor space occupied is only 3½ feet by 5 feet and the height 6½ feet. Automatic controlling devices regulate the supply of feed-water to the boiler and of oil to the burners, making the boiler immediately responsive to the demands for steam.

The water enters the upper part of the boiler and the steam is discharged from the lower part, where the heating surface is directly in contact with the highest furnace temperatures. With the water and gases of combustion circulating in opposite directions two important advantages are obtained; first, the uptake gases are delivered at a much lower temperature than that of the steam generated, thus enabling the boiler to be operated at a high rate of thermal efficiency, and second, the rapid circulation of water tends to eliminate the formation of scale in the tubes and keeps the tubes clean.

Construction

The boiler consists of a number of specially cored, crucible steel headers arranged horizontally one above the other into each of which are screwed several groups of single-ended tubes also arranged horizontally. The free ends of the tubes are welded and flattened to permit the use of a wrench in removing or installing them. Inside the tubes, as shown in Fig. 2, are smaller circulating tubes leading into separate cored spaces or chambers in the header. The peculiar coring of the headers causes the water which enters at one end of the header to pass through the group of inner or circulating tubes leading from the first core or chamber and return through the outer tubes to the next core or chamber, which in turn connects the outer tubes of the first group with inner tubes of the next group of circulating tubes and so on. As the water passes successively through the groups of tubes in each header, beginning at the top and finally issuing at the bottom as steam in order to prevent the water from gravitating at once to the lower part of the boiler. Each header is conneced to the next header below it by a trap.

Two somewhat smaller headers are arranged obliquely at the sides of the furnace, while at the back of the furnace is a crucible steel wall so cored that the steam from the top of one of the side headers is carried through this wall to the bottom of the other side header, which is the last header in the series of circulation. This coring is so proportioned that a high velocity is maintained throughout during the operation of the boiler.

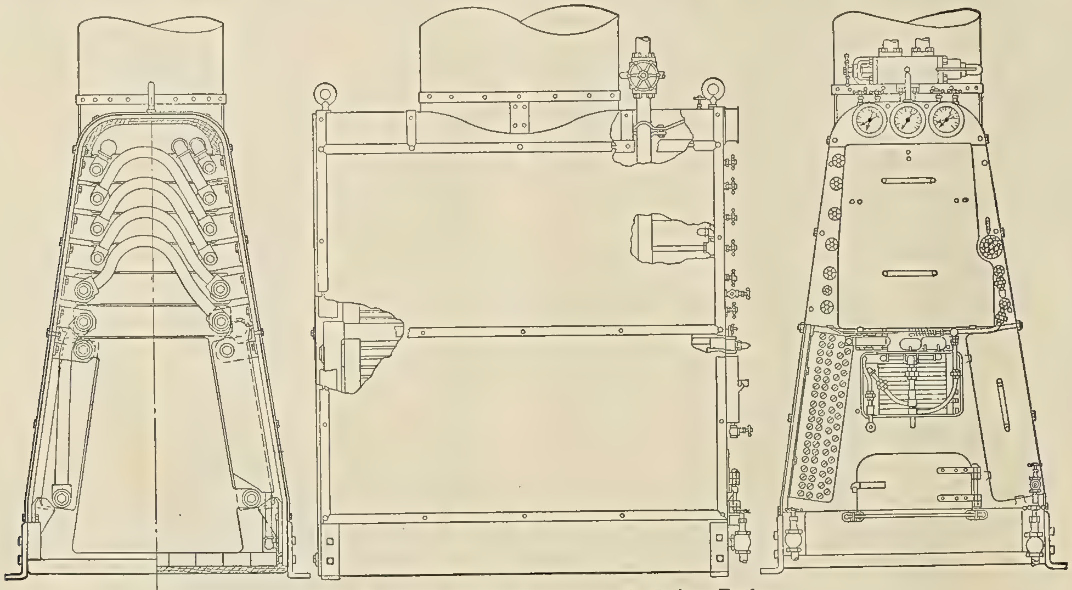


Fig. 2.—Side and End Views of Talbot Boiler

The tubes and headers are supported on a framework consisting of four vertical stanchions. A jacket is secured to the outside of the stanchions or framework and the space between the tubes and these panels is insulated with asbestos-magnesia. At the opposite end of the boiler from the header end are tube-supporting plates and a door frame which protects the tube sheets from the intense heat of the furnace. The tube sheets are secured to the framework in the same manner as the headers.

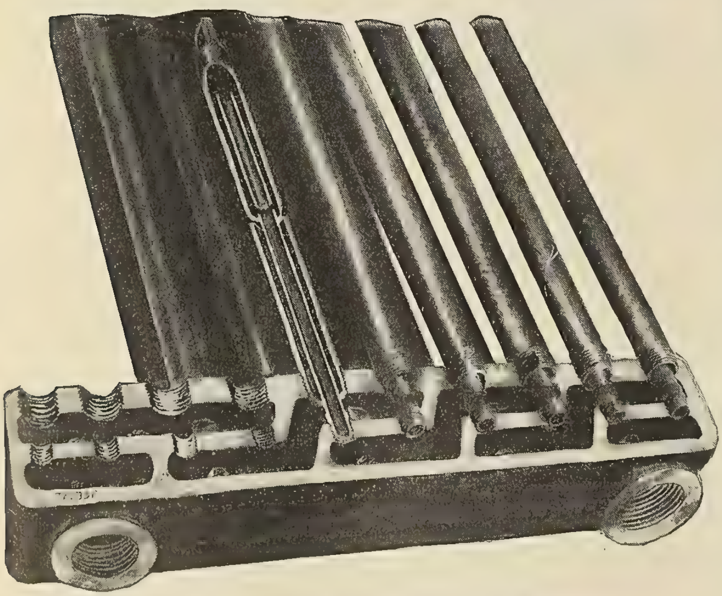


Fig. 3.—Header, Showing Arrangement of Tubes

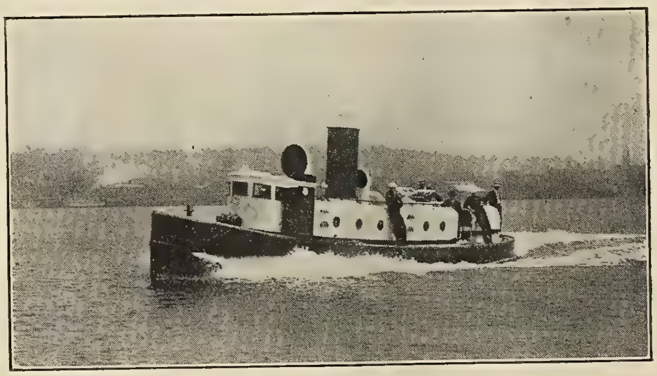


Fig. 4.—Naval Tender Fitted with Talbot Boiler

Feed Regulator

On the door frame at the front of the boiler, through which the feed water first circulates, is an automatic feed regulating device of the piston type operated by compound levers connected to one of the nearby tubes in the last group of the circulating series. The position of this regulating tube is such that it is subject to the greatest heat not only of the furnace, but from the steam within the tube. As the tube becomes hotter and expands, the valve connected to it is actuated by the connecting levers, so that it admits water to the boiler, which in turn cools and contracts it, reducing the supply of water to the boiler.

It is claimed that when steam enters, this valve adjusts itself automatically and remains with a certain opening under ordinary working conditions. After the feed has passed through the door frame and through this valve, it is delivered to the upper header at the top of the boiler through a hand regulated valve designed to adjust the superheat within certain limits and to steady the action of the automatic regulating device.

An automatic safety device operated by the regulating tube is also provided which cuts off the oil to the burner when the heating surface of the boiler becomes overheated. The simple nature of the regulating devices on this boiler and the use of oil fuel make the boiler very easy to handle, while the savings in weight and space, and the economy of fuel consumption, make the boiler particularly suited for marine work.

In a conspicuous place at the top of the boiler are gages showing the oil pressure, the feed-line pressure and the steam pressure, and also a temperature gage connected to the regulator tube which shows the water conditions in the boiler.

Lengthening the Steam Yacht Cyprus

The steam yacht *Cyprus,* described in the December, 1913, issue of International Marine Engineering, has recently been lengthened 35 feet at the yards of the Seattle Construction and Dry Dock Company, Seattle, Wash., for Mr. D. C. Jackling, of Salt Lake City. The vessel was altered from specifications by the original designers, Messrs. Cox & Stevens, New York, and under their supervision. The work consisted of adding about 35 feet between the engine and boiler rooms, lengthening both and forming additional fuel oil tanks, quarters to accommodate twelve of the crew and three assistant engineers and four large staterooms for guests. A raised forecastle was also added, giving the boat a decidedly better profile and more crew accommodation.

Fig. 1.—The Altered *Cyprus*

The present dimensions of *Cyprus* are: Length overall, 266 feet; length on the waterline, 250 feet; beam, 28 feet 6 inches; extreme draft, 13 feet 6 inches.

The lines show a vessel with fine entrance and easy run, considerable deadrise at all sections, a good hard bilge carried well toward the ends, ample freeboard and

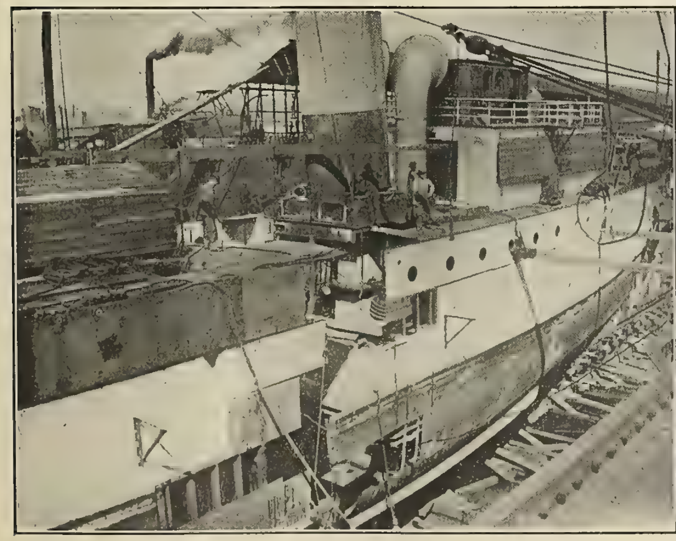


Fig. 2.—Starting to Pull the Two Sections Apart

Fig. 3.—Original Hull Pulled Apart 35 Feet

pleasing sheer, a full deck line associated with a pronounced flare forward, and a raised forecastle containing quarters for the captain, mate and pilots. From end to end the sides are carried up to the upper deck level, and to relieve the effect of this continued high side, large heavy plate glass windows 1 inch in thickness are placed in all the main saloons. Two large deckhouses of steel on the upper deck, the forward one containing dining room and pantry, the after one the wireless room and entrance hall, are so disposed and proportioned that with the two funnels of generous size and two pole masts equipped with wireless a most symmetrical and workmanlike appearance is secured, so that the remodeled *Cyprus* looks every inch a seagoing steamer.

The accommodations for the owner and guests comprise a total of thirteen large staterooms, none less than 10 feet in length, and for the use of the occupants of these rooms nine bathrooms are conveniently arranged.

An interesting feature in connection with the entire scheme of the quarters for the owner and his guests is that from each and every stateroom and living room, access may be had to all the other living rooms and staterooms without any necessity of going out on deck.

The arrangement of the living quarters for the crew and servants has been most carefully thought out, and notwithstanding that the total crew of 48 men has to be accommodated, unusually liberal quarters are provided. The valets and personal servants have quarters on the berth deck aft, where a separate bathroom is provided for their exclusive use. On the berth deck amidships, in between the engine and boiler room, are the quarters for the engineers, firemen, water tenders and oilers, these quarters having a separate mess room and two well-equipped bathrooms. On the berth deck forward are the quarters for a portion of the ordinary seamen with a separate mess room, toilet and wash room. Immediately aft of these quarters will be found the rooms of the cooks and stewards, these employees having a separate bathroom for their use. On the main deck forward the balance of the ordinary seamen are taken care of, the second mate also having a separate stateroom in this space. The raised forecastle contains a very comfortable stateroom for the captain with a private bathroom opening off the same, and also a stateroom for the first officer and for the pilot. On the main deck amidships is situated the officers' mess, which is readily accessible from the various officers' quarters. The galley for the crew, a bakery and a very large well-equipped separate galley for the owner are also located on the main deck amidships. On the main deck abreast the engine hatch on the port side is the chief engineer's stateroom, an excellent arrangement in every way.

The propelling machinery consists of two four-cylinder triple expansion, vertical inverted reciprocating engines having cylinder diameters of 16 inches, 26 inches, 30 inches and 30 inches, with a stroke of 24 inches. These engines, built by the Seattle Construction & Dry Dock Company, are designed to turn at 225 revolutions per minute; at 210 revolutions per minute each engine develops 1,500 indicated horsepower. Each of the main power units is supplied with a complete condensate system using condensers of 1,500 square feet of cooling surface each. There is also a Reilly multicoil feed-water heater with two long stroke feed pumps of the Blake type and two Davidson evaporators, each having a capacity of 12 tons in 24 hours. Fresh water is distributed in six tanks, making a total capacity of 110 tons.

Steam is supplied at 225 pounds pressure by four Babcock & Wilcox boilers having a total heating surface of 10,600 square feet. The boilers are fitted with Dahl burners, made by the Union Iron Works, San Francisco, for burning the fuel oil which is stored in eleven tanks having a total capacity of 360 tons. One donkey boiler of the Roberts type supplies enough steam to start the burners. This boiler has 600 square feet of heating surface and is situated for convenience in the after port corner of the main boiler room.

There is one steering engine of the Hyde type in the upper engine room, and a steam windlass of the Providence type, as manufactured by the American Engineering Company, Philadelphia. The refrigerating plant is very complete, comprising a one-ton Allen ice machine which has an auxiliary arrangement for making ice at the rate of 100 pounds per day.

The ventilating system contains five separate units, four discharging cooled air into the quarters and engine room, and one suction unit for the two galleys and bakery. Schutte & Koerting blowers maintain the proper draft and the air is cooled by passing it through a system of pipes in a tank through which sea water is circulated. The forced draft system in the boiler room is maintained by a Kerr turbine blower having a capacity of about 25,000 cubic feet per minute.

Electric current for the entire boat is supplied by two generators, one turbo-generator, 25 kilowatts, of the Allis-Chalmers type, and one 20-kilowatt generator with a reciprocating engine as manufactured by the General Electric Company. There is also a very powerful Marconi wireless apparatus and one 18-inch General Electric searchlight.

The propellers, of which there are two, are three-bladed with 8 feet 4 inches diameter and 9 feet 8 inches pitch. These give the boat a speed of about 18 knots when turning at 210 revolutions per minute. At the most economical speed, about 12 knots, the vessel has a cruising radius of about 7,000 knots.

The Boston Fish Pier

BY FREDERICK ROCHE

At Boston, Mass., the greatest fresh fish market in the United States, and the chief distributing point for the fresh fish supply of the entire country, the largest pier in the world devoted entirely to the fisheries has recently been completed. Constructed under the auspices of the Commonwealth of Massachusetts, the new pier cost $3,000,000 (£615,000). With its surrounding buildings on Northern Avenue, South Boston, the pier forms a city by itself. It is 1,200 feet long, 300 feet wide, of fireproof construction, being built of stone, concrete and brick. The plant of the Boston wholesale fish dealers, which stands at the head of the pier, includes the largest cold storage plant in the world.

The cold storage plant was built by the Commonwealth Ice & Cold Storage Company, a corporation in which the wholesale fish dealers are the largest stockholders. The plant of this corporation consists of a large cold storage building, having a capacity for over 15,000,000 pounds, and where 200,000 pounds of fish may be frozen each day; an ice factory where 360 tons of ice may be produced each day and 8,000 tons of ice stored; a power house which provides light, heat and water pressure for the entire pier and its surrounding buildings.

Cold Storage Plant

The buildings of the cold storage plant, built of reinforced concrete, tower above the other structures of the pier and are surmounted by a tower 100 feet high. The

concrete walls are lined with cork board covered with cement mortar applied with cement guns, which insulates them from the heat of the atmosphere. The buildings are provided with an elaborate system of electric elevators and lifts of great speed and capacity.

The main building of the plant, situated directly on Northern Avenue, is 220 feet long, 100 feet wide and eight stories high with a basement, which makes it practically a nine-story structure. An archway through the center of this building provides entrance for teams and for freight cars, so that the latter may be loaded with goods from the freezing chambers. The freezing chambers, where the fresh fish are frozen, are kept at a temperature many degrees below zero, and fish remaining here for 24 hours are frozen solid. Upon being taken from the freezing chambers, the fish are dipped several times into water tanks, which cover them with a thin film of ice, after which they are placed in the storage chambers. The lower floor of the building, in which the ice is made, is used as a storage chamber, and its ceiling is 60 feet from the floor. The ice manufacturing apparatus is on the fourth and fifth floor. If the ice is to be used at once, instead of being lowered by elevators to the storage chamber below, it is hoisted to the top floor to the ice crushing room, where three large ice crushers are located. Before being delivered to the fish dealers or the fishing boats, the ice is run through these machines, and is ground into small bits ready for use. From the bottom of these machines the ice is delivered by gravity either into steel cars, running on an electric industrial railway over the roofs of the fish stores, or into specially constructed electric motor trucks. The steel cars convey it over the roofs to chutes leading into the ice boxes of the fish stores, while the trucks convey it to the vessels berthed at the pier.

Fig. 1.—New Boston Fish Pier. View from the Harbor

Machinery Equipment

The whole plant is so planned and constructed that manual labor is done away with, automatic machinery taking its place. For example, coal is brought to the pier in barges, delivered into a car at the edge of the wharf, passes through an electrically operated crusher to an automatic scale, thence into a belt conveyor through a tunnel to the basement of the boiler house. A chain bucket apparatus lifts it from here into a coal pocket, situated above the four large vertical watertube boilers, which have a capacity of 2,000 horsepower. This coal pocket has a capacity of 500 tons, and is so arranged that it feeds the coal automatically into the furnace stokers, which are also automatic. The refrigerating machines, of which there are four at present, are in the machinery building.

Fig. 2.—Generators and Switchboard

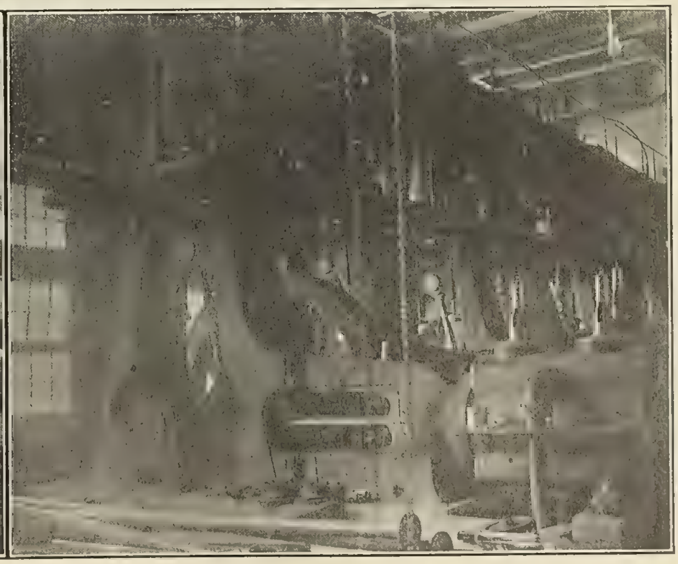


Fig. 3.—Refrigerating Machines

Each machine has a capacity of 1,200 tons when operated at a very slow speed. They are driven with cross compound condensing engines, which in turn are operated with highly superheated steam at a pressure of 175 pounds per square inch.

Electric generators connected with the engine, and a large motor generator set, making a total of 1,000 kilowatts capacity, supply power and light for the entire plant, and are also used for charging storage batteries for the electric trucks used in ice delivery.

Stores

From the cold storage plant down the pier, in two parallel rows, separated by an avenue 100 feet wide, where all the teaming is done, are two three-story structures of concrete and brick which house the stores of the wholesale fish dealers. The exterior of these buildings is the same, but the interior of each store differs slightly from that of its neighbor. All were constructed on the same general plan, and with the same end in view. The floors and walls are of concrete, finished with enamel paint, which gives them the appearance of tile The floors slope gradually toward the center, where a drain is located, and each store is provided with a hydrant connected with the high-pressure salt water system, which is used daily for washing out the entire place. The offices of the 44 separate concerns in business on the pier are located on the second floor of the store buildings, facing on the center avenue before mentioned. The third floor, and in some cases the rear part of the second floor, is used for the storage of boxes and barrels.

The Fish Exchange

At the end of the pier stands the Administration Building, where the New England Fish Exchange, Boston Fish Market Corporation, Commonwealth Ice & Cold Storage Company, and the commission dealers have their offices. This building is square, constructed of brick and concrete, and like the stores is three stories high. The ground floor is taken up almost entirely by the New England Fish Exchange, founded in 1908 as the clearing house of the wholesale fish business. It is upon the floor of this Exchange that all the fish brought to the pier are bought and sold at auction. The room in which the buying and selling is done is a large square room well lighted by a number of small windows, as well as by a series of French windows, which take up practically all one side of the room toward the harbor. The center of the room is occupied by a big oblong wooden platform upon which the fishing captains stand when offering their fish for sale.

On Northern Avenue are located two parallel rows of two-story concrete buildings, one row of which is situated nearer the water houses and oyster and lobster dealers. The row on the opposite side of the street is occupied by ship chandlers, cigar stores, barber shops, restaurants and other trades people.

Suez Canal Improvements.—To meet the impending competition from the Panama Canal, numerous improvements are being pushed forward on the Suez Canal. Last January the maximum draft of water was increased to 29 feet, as compared with 24 feet 4 inches when the waterway was opened in 1869. It is now announced that by means of powerful dredges another foot will be added to the depth early next year. The International Consultative Committee of Works, of which Sir William Matthews and Mr. Anthony Lyster are the British representatives, have produced plans which provide for a maximum draft of 40 feet throughout, while various sections of the canal are to be widened and lengthened.

The Harris Heavy Oil Marine Engine

For a long time marine engineers have been looking for a reliable heavy oil engine which is not only less complicated than the usual type of Diesel engine, but which is also without the serious faults which have so greatly militated against the widespread adoption of the Diesel engine on board ship. The general advantages of the Diesel engine, such as savings of weight and space and the remarkable economy of fuel consumption, are fully recognized, but so far these benefits have been obtained only by the use of complicated valve and maneuvering gear requiring delicate adjustment and constant attention and the use of extreme ranges of temperature in the working cylinders which are detrimental to the cylinder walls,

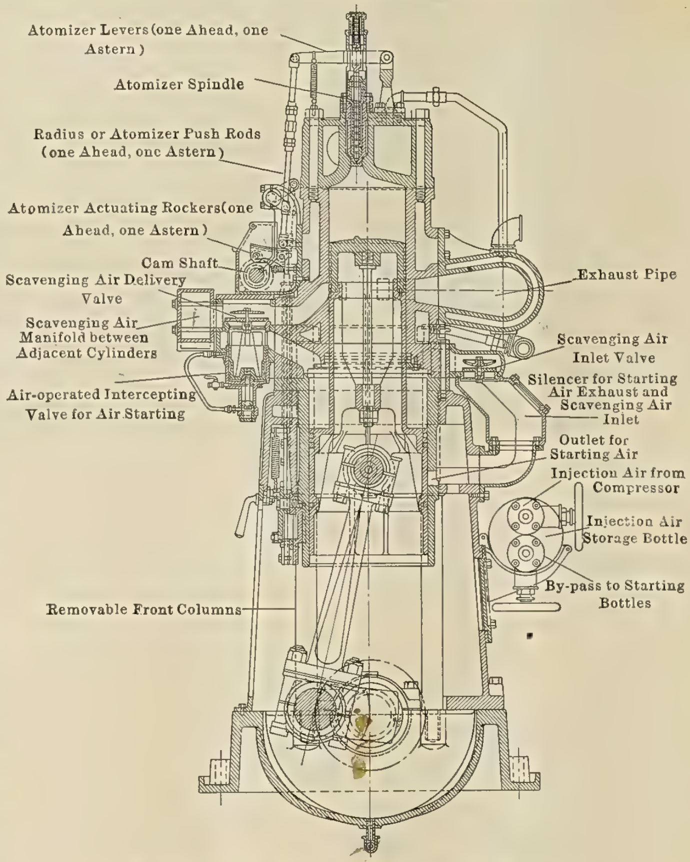


Fig. 1.—Cross Section of the Harris Engine

heads and pistons. A new heavy oil engine has been developed, however, by the Harris Patents Company, Philadelphia, Pa., which has apparently overcome many of these objectionable features to a great extent and which also brings out a number of new features both in the construction and in the method of operation which vastly improve the working of the engine.

The Harris engine is of the two-cycle type, built in two, four, six or eight cylinder units with a two-stage vertical air compressor worked off the crankshaft. In operation it is the nearest approach to the ordinary steam engine that we have yet seen. The entire control is by means of a single hand wheel which, through interlocking devices that preclude mistakes on the part of the engineer, enable him to start the engine on compressed air and gradually build up its operation on oil while still working on air, or to reverse it from full speed ahead to full speed astern in a few seconds. Further, the engine can be started immediately with the load on or it can be slowed down to a few revolutions per minute with the same certainty and with even greater ease than a steam

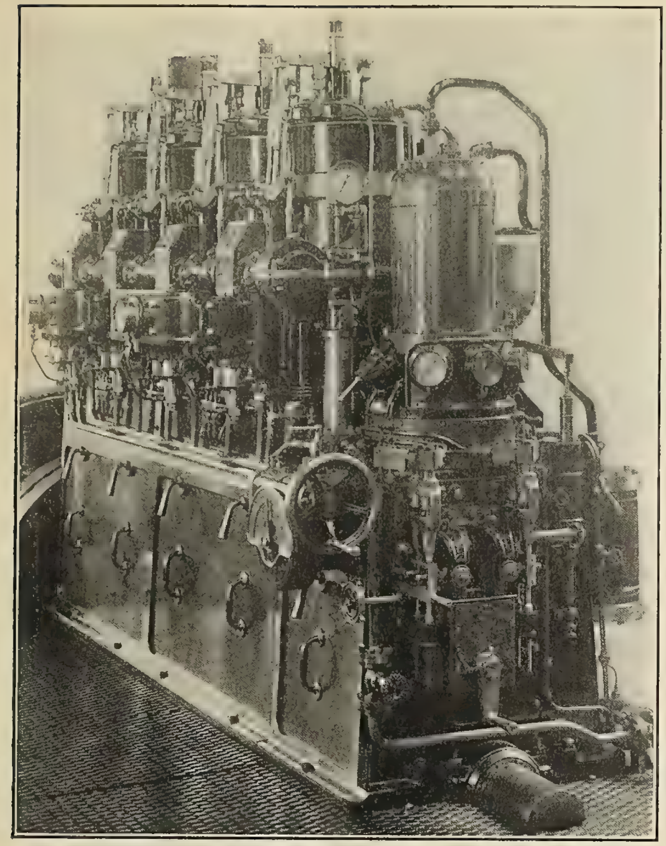


Fig. 2.—End View Showing Control and Air Compressor

In place of the six or seven valves with their complicated valve gear, which are usually found in the cylinder head of a Diesel engine, the cylinder head of the Harris engine is entirely without valves, except for the single fuel atomizer by means of which the oil fuel is introduced to the cylinder. Stepped pistons are used, the enlarged extension of the main piston working in a cylinder below the working cylinder and acting not only as a scavenging pump for the adjacent cylinder, but also as an air motor for working under compressed air when starting or reversing the engine. In fact, the scavenging cylinders can

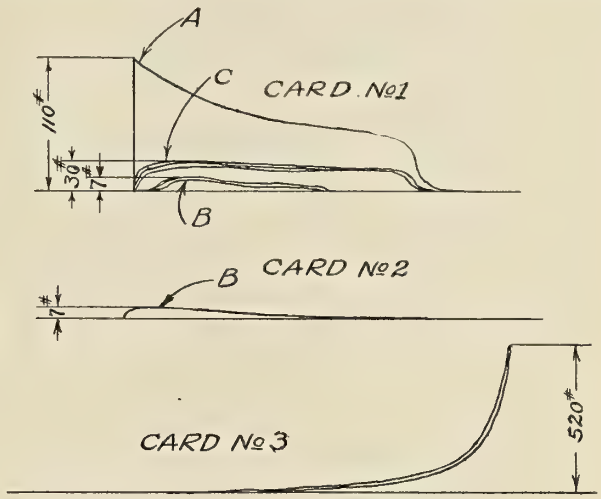


Fig. 4.—Indicator Cards from Harris Engine

engine of similar power. To fully understand how these results are obtained it is necessary to trace out the construction of the engine and its method of operation.

still continue to run on compressed air while the working cylinders are performing their normal functions and operating on oil. The added advantage of this arrangement,

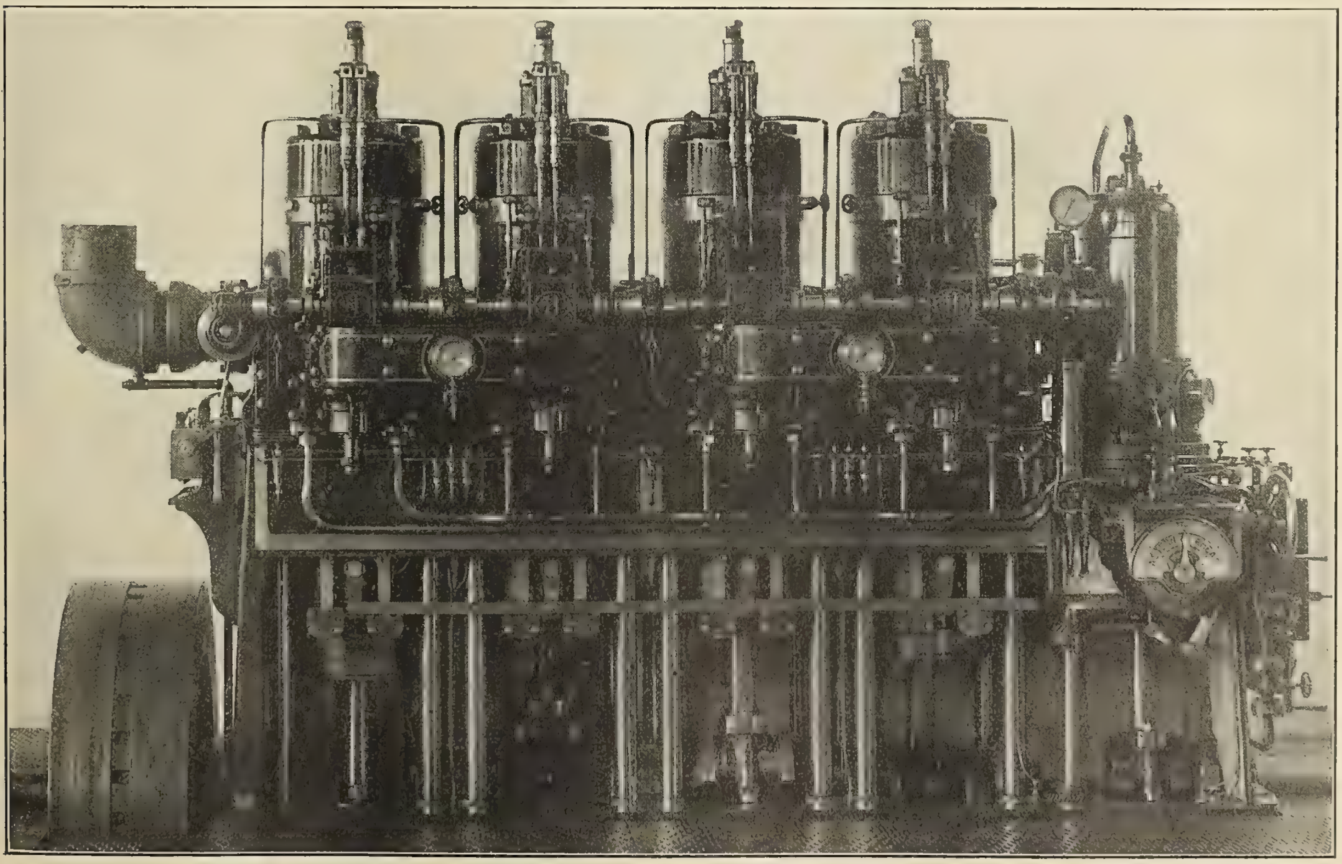


Fig. 3.—Four-Cylinder, 240 Indicated Horsepower Harris Heavy-Oil Engine (Front Removed)

aside from the fact that the working cylinders are not subject to the low temperatures caused by working on compressed air, lies in the fact that each scavenging piston, having a greater area than the working piston, allows the engine to be started with 175 pounds air-pressure instead of the usual 800 to 1,000 pounds employed in Diesel engines, and, further, in starting and reversing the engine the atomizer valves do not operate while starting on air until the engineer wishes them to do so; consequently, all the usual bypass valves are eliminated and the temperature of the fresh charge of air in the cylinder is quickly raised, owing to the absence of the chilling effect caused by an air blast entering through the atomizer valve without fuel on each stroke while starting on air.

A better understanding of this arrangement can be obtained by referring to the indicator cards Nos. 1, 2 and 3 shown in Fig. 4. Cards 1 and 2 were taken from the scavenging or step cylinder while starting on air without pumping oil to the working cylinders. The line *A*, Card 1, represents the first outward stroke or initial inlet of air on the scavenging piston, showing that it requires only 110 pounds per square inch to act on the step piston to force upward the adjacent main working piston against its compression pressure of about 500 pounds per square inch. The reason why only a low pressure is required for this work is due to the enlarged area of the step piston against which the air expands. Line *B* represents the return of the above stroke of the step piston and shows that it performs its normal function of compressing a charge of scavenging air to 7 pounds per square inch. The line *C* represents the second and all consecutive upward strokes of the step piston, until the starting air is shut off by the engineer. The reason why only 30 pounds pressure on the step piston is required after the initial stroke is due to the fact that the pure air compressed in the working cylinder on the upward stroke of the piston expands on the downward stroke, thus assisting the air motor and recovering most of the work expended in compressing the air in the working cylinder. Card No. 3 was taken from the working cylinder at the same time that Card No. 1 was taken in the scavenging cylinder, and shows the compression and expansion of air in the working cylinder. Line *B* in Card 2 represented the normal function of the step piston delivered on the upward stroke, 7 pounds per square inch scavenging air pressure in starting air being admitted. This is the normal card which is given by the scavenging cylinder when running on oil.

The foregoing cards show that the step piston of the Harris engine performs three functions in three half revolutions, namely: first, one-half stroke downward, high-pressure air motor, 110 pounds; second, one-half stroke upward, scavenging pump, 7 pounds; third, one-half stroke downward, low-pressure air motor, 30 pounds.

Another advantage of the step piston construction in the Harris engine is that the step or lower piston and the wrist pin in it are not subject to high temperatures and consequent expansion, and, therefore, can be made a nice fit in the lower cylinder and act as a circular crosshead for the main piston. The main pistons can, therefore, have ample clearance between themselves and the cylinder walls, while the piston rings are called upon to perform only their natural function of preventing the escape of gases from the working cylinder past the piston. This construction, therefore, makes possible a smooth running engine without the noisy side flogging usually encountered in the ordinary "trunk" piston type Diesel engine.

In the construction of the engine the design of a marine steam engine has been followed as closely as possible, particularly as regards the crankshaft, bearings, connecting rods and lubrication. The cylinders are supported on columns and the engine may be operated either as a closed or open front engine, the front consisting of light panels which may be instantly lifted off by hand while the engine is running. A feature which will appeal to marine engineers is the fact that the front columns can be quickly removed and the entire crankshaft rolled out on the floor without further dismantling the engine or interference with overhead gear. The main bearings can be changed by simply removing the cap of the bearings without disconnecting the shaft or even taking the weight off the crankshaft. Lubrication of all parts except the cylinders, crosshead and wrist pins is by gravity, while a special oiling device is provided for the main bearings from below. The crank pit drains lead to a common pump, which circulates the lubricating oil to a receiver separator, extracting dirt and water and thence passing the oil to a filter and supply tank.

Along the side of the engine is a single cam shaft on which are two cams for each cylinder, one for ahead and the other for astern motion. These cams actuate rockers, which in turn actuate push rods bearing on them to lift the atomizers in the cylinder heads. The push rods, however, are not brought into play until they are moved out through a small arc by a system of rods and crank levers connected to the control wheel. If the control wheel is moved from mid-position toward the go-ahead position, it first admits air to an air-operated, intercepting valve admitting compressed air to the step piston, starting the engine on air. As the control wheel is advanced still further toward the ahead position the atomizer push rod over the ahead cam is moved out on its rocker and lifted by the cam, consequently admitting oil to the working cylinder. When the control wheel has reached the full speed ahead position the lower end of the ahead push rod has been moved out to the end of its rocker and receives the full lift of the ahead cam, opening the atomizer valve to its fullest extent. This arrangement, however, not only affects the amount of lift of the atomizer, but also the time of the lift, which amounts to the same thing as advancing the spark in an automobile engine, with its consequent advantages.

The various parts of the engine are shown in Fig. 1. Scavenging air is admitted to the working cylinder through ports in its circumference, while the exhaust gases from the working cylinder pass out through ports located opposite the scavenging ports and so arranged that the piston opens and closes them at the correct time during its travel. Besides the scavenging air and exhaust ports in the cylinders, there is only one other opening in the working cylinder, and that is a small opening in the cylinder head for the admission of oil from the atomizer.

Oil is supplied to the atomizer by a variable stroke pump for each cylinder. The variation of stroke is automatically controlled by a centrifugal governor, or the pumps may be operated by hand. The governor controls the discharge from the fuel pumps and does not lift the suction valves, as is commonly done in Diesel engines. Once the delivery pipes to the atomizers and suction supply from the service tank have been cleared of air there is always a solid stream of oil from the service tanks to the atomizers, and the slightest movement of the pump plunger produces a corresponding movement of the column of oil, forcing a definite quantity of oil into the atomizer, or, if the stroke be increased by the governor, a corresponding additional amount of oil would be supplied.

The oil is delivered from the service tank to the pumps

under air pressure, which is taken care of by the engine, and may be anything from 5 to 100 pounds per square inch, making it immaterial where the service tank is located. There is no suction or pumping backwards, and if the governor cuts the pumps out of action entirely, the oil in the line is stationary and under pressure too ready to respond to the slightest movement of the pump plungers. It is claimed that hand pumping is necessary when starting, even after weeks of idleness. The stroke of each or all of the pumps may be varied either mechanically or by hand, all at once or each independently.

A unique device also permits the engineer to vary the speed of the engine instantaneously while the governor still maintains complete control of the operation of the engine at whatever speed the engineer wishes to operate it. It is also possible for the engineer to set the speed control at any predetermined speed before starting the engine, and when started it is claimed the engine will come to this predetermined speed and remain there. This speed control feature is especially useful in the case of a heavy head sea, when the engines are likely to race, and will perform the same work as that of an engineer at the throttle of a steam engine under similar circumstances.

In starting or reversing the Harris engine, air at from 175 to 300 pounds pressure acts on the step pistons, turning the engine over with its load on as long as the engineer desires to do so. After the first stroke, as previously explained, a pressure of only about 30 pounds is required; thus the engine is extremely economical in the use of compressed air when starting or reversing. After the momentum of the engine is built up by working on air, the oil can be given to the main cylinders, the air still being allowed to act on the step pistons. This will augment the power being developed from the main pistons, and, if it is desired, both the main and step pistons can be acting at the same time, the former on oil and the latter on air. The action of the air on the step pistons in no way affects the working conditions in the working cylinder, nor does it affect the step piston's normal function of acting as a scavenging pump. This feature is a distinctive advantage for a marine engine, as it allows the vessel to respond more quickly and with more certainty in a case of reversing from full speed ahead to full speed astern.

Reversing is accomplished by moving a single rod on each cylinder and does not require the movement of the cam shaft or the lifting of valve levers off the cams by compressed air, as is usually necessary in the purely Diesel engine. In the Harris engine the same wheel or lever which admits the starting air and the fuel oil controls the movement of the rods. The engine has exactly the same functions and power when running either ahead or astern. The simplicity of the reversing mechanism, the additional power from the air motors, the unchanged conditions in the working cylinders and the fact that it is not necessary to shut off the fuel when reversing, all combine to make the Harris engine extremely simple and easy to handle.

The two-stage air compressor driven off the main shaft is mounted at one end of the engine with a control valve on the suction. The inter-cooler between the first and second stages is in the water jacket of the second stage, while an aftercooler is fitted between the second stage and the air bottles with an independent water circulation. Starting air bottles may be charged by the main engine while running, through a special type of reducing valve or by an auxiliary compressor. Bilge and circulating pumps are mounted diagonally on the forward end of the bed plate, and are driven optionally by eccentrics, or of the rotary type, the valves being fitted with quick-opening valve boxes.

Two marine sets have been running in the builder's shops for some time with excellent economy and without any signs of breakdown or trouble of any kind. The larger set, shown in Figs. 2 and 3, is of 240 indicated horsepower. A smaller two-cylinder set has run successfully on Mexican crude oil of 19 gravity, a very thick, solid oil. The 240 horsepower engine weighs approximately 25,000 pounds. Its cylinders are 9 inches diameter with a stroke of 13 inches and at normal speed runs at 300 revolutions per minute.

Protection of Battleships Against Submarine Attack*

BY PROFESSOR SIR JOHN H. BILES, LL.D., D. SC.

Assuming that very serious damage will be done to a battleship or cruiser by the explosion of a torpedo, the question is what can be done to prevent or seriously reduce this damage. Subdivision naturally suggests itself as one means of minimizing the effect of this damage, but, when all that is possible in this direction has been done, there seems to be no great certainty that a battleship will be still a formidable fighting machine after having received the successful contact explosion of a 21-inch torpedo. Can we do anything in addition to subdivision to preserve the ship for effective fighting purposes?

To some it may seem that the readiest way to approach this problem is to clothe the bottom of a 25,000-ton battleship of the latest pattern with armor, and to increase her fulness sufficiently to allow her to carry this armor, letting everything else remain unaltered. The only considerable effect will be to reduce the speed by 2 knots.

Briefly, the points for discussion are as follows:

(1) Is 4-inch armor sufficient protection against torpedoes to justify its adoption in battleships of the class of the later dreadnoughts?

(2) Is the submarine menace of sufficient importance to justify the adoption of 4-inch armor protection on the bottom?

(3) Is the submarine menace of sufficient importance to justify the building of smaller, slower battleships of, say, 16,000 tons displacement of 18 knots, having six heavy guns each instead of eight or ten, as in the larger ships?

(4) Is the method of applying armor to the bottom of sufficient value in itself to justify the adoption of a form of ship which offers greater resistance than the ordinary form?

These are some of the points which suggest themselves for discussion. The form and arrangement of existing ships, though not revealed to us by the Admiralty, may be considered, for this purpose, as sufficiently well known to many to make it unnecessary for a third design to have embodied in this paper. If it should seem to be desirable to further consider this question of protecting battleships from submarine attack, it will be necessary to determine by experiment the effect of the explosion of a torpedo upon armor attached to a ship. If the submarine menace is judged to be really serious, the necessity for carrying out such experiments seems to be undoubted.

DELIVERY OF THE ARGENTINE BATTLESHIP RIVADAVIA.—The Argentine battleship *Rivadavia,* constructed at the Fore River shipyards in Quincy, Mass., was turned over to the Argentine government August 24.

* Extract from a paper read before the Institution of Naval Architects, Newcastle-upon-Tyne, July, 1914.

The Watertight Subdivision of Ships and the Effect of Bilging—V

BY A. L. AYRE

The conditions contained in the above example and calculations to a large extent appear to agree with those occurring in the lamentable *Titanic* disaster, and it is quite easily seen why that vessel foundered after having a similar amount of her length exposed to the sea. The loss of the *Titanic* was one occurring under most abnormal circumstances in almost every respect, and appear to be such that could not with reason be fixed as the standard of test for efficiency in watertight subdivision. It does appear, however, that, without admitting these abnormal circumstances as being the standard test, something further may be done in the way of increasing the efficiency of the subdivision in very large vessels where a large number of lives and much valuable property are involved. Even if we presume that the shell damage had only extended over equal corrected mean sinkage $30 \times 5.20 = 35.2$ feet mean draft in damaged condition.

In considering the question of trim (presuming the vessel to remain in the upright position transversely for the time being), vast differences are found in the relative figures throughout the calculation, and the trimming moment is found to be 60 percent less than before, while the *M. C. T.* 1″ is found to be 44 percent greater. The resultant effect of these two differences is that the total amount of trim is 72 percent less, which, together with 58 percent less mean sinkage, produces the waterline $W_2\ L_2$ in Fig. 14, which will be seen to be vastly different to $W_1\ L_1$ produced by the calculations based on both sides being bilged.

It is at once seen that a very great advantage results from the point of view of trim, owing to this further subdivision of the vessel. We may now take the more important effect of the longitudinal bulkheads on the transverse stability of the vessel. It has been seen above that for

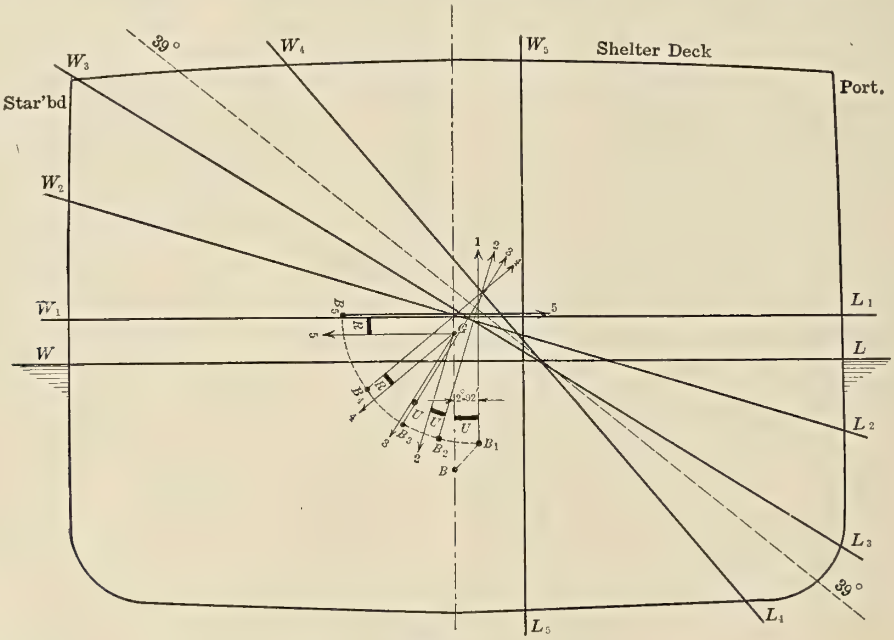


Fig. 15

one-half of the length of the plating which was taken in the foregoing example, it is quite likely that three compartments would have been flooded instead of four, and while the damage itself would not have been so abnormal, yet the effect would have been quite as dangerous, either from the points of view of buoyancy and trim or straining.

Centerline longitudinal bulkheads have been advocated as a further means of subdivision, and while their dangerous effect had been dealt with in the case of an earlier example it will be interesting to note their effect in the case of the large vessels taken in the latest example. We will assume the starboard side to be bilged and the port side remaining intact. The amount of lost buoyancy and lost area of waterplane will be now exactly half in each case, these becoming, respectively, 6,382 tons and 7,808 square feet. The area of the intact waterplane will now be $49{,}280 - 7{,}808 = 41{,}472$ square feet.

The amount of mean sinkage is now found by

$$\frac{6{,}382 \times 35}{41{,}472} = 5.38 \text{ feet, depth of layer of sinkage.}$$

Correcting for the difference in area of waterplane within the depth of the above layer, we can say 5.20 feet this condition the amount of lost buoyancy is 6,382 tons. The center of gravity of this buoyancy lies at a position which is 15.1 feet from the centerline out to starboard. The net area of intact waterplane, as in the previous case, is $49{,}280 - 7{,}808 = 41{,}472$ square feet, and the center of gravity of the lost area is 18.4 feet from the centerline out to starboard.

Owing to the withdrawal of waterplane area on the starboard side the center of gravity of the waterplane will move out to port to a position equal to

$$\frac{7{,}808 \times 18.4}{41{,}472} = 3.47 \text{ feet from the centerline,}$$

and which can also be taken to represent the position of the center of gravity of the added layer. We therefore see that 6,382 tons of buoyancy are lost at a point 15.1 feet out on the starboard side, and added at a point 3.47 feet out on the port side. The total shift is therefore 18.57 feet, and the moment of transference $6{,}382 \times 18.57 = 118{,}400$ foot-tons.

This moment of transference is also equal to an upsetting moment of statical stability. Dividing this moment by the total displacement we obtain the new position of

the center of buoyancy for the upright condition, and measured relative to the centerline out to port 118,400 ÷ 40,500 = 2.92 feet, and which is also equal to an upsetting lever of stability acting on the vessel in the perpendicular condition.

While the holds are filling the waterline is rising and the vessel inclining to port. If we imagine the sinkage to first of all take place vertically to its full extent, as

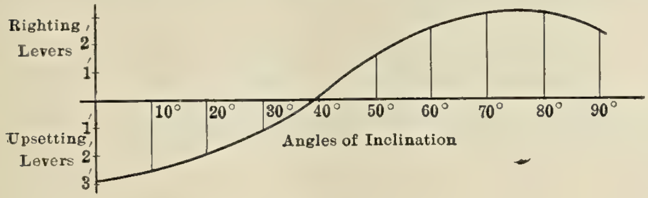


Fig. 16

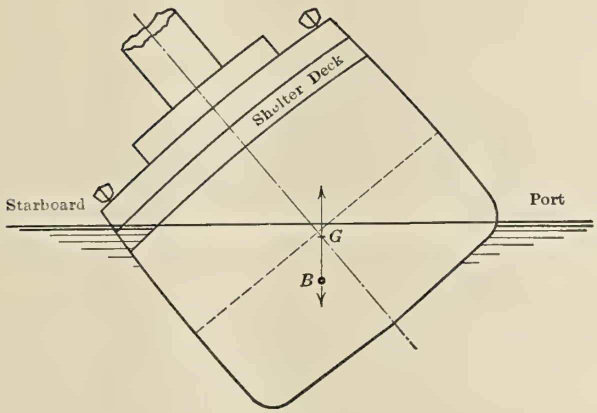


Fig. 17

above given, *i. e.*, 5.20 feet, we obtain the waterline $W_1 L_1$, as shown in Fig. 15. The center of buoyancy also rises on this account, and owing to the bilging of the starboard side only we have seen that it also moves out to port. The new position of the center of buoyancy therefore becomes that shown by B_1 in Fig. 15. Let us now consider the inclination to port. Fig. 15 shows the relation of the forces of gravity, given by calculations, at five positions, the corresponding waterlines, position of center of buoyancy and direction of gravity being shown by the respective figures 1 to 5. The first position is the one we have just imagined, *i. e.*, upright and total vertical immersion. Here we have the upsetting lever of 2.92 feet. The second and third positions also show upsetting levers (represented in the figure by the letter U). In the fourth position we see that the relation of the forces has changed, the force of buoyancy now appearing on the left-hand side of the gravity force and producing a righting lever (shown by R). The fifth position is one also having a righting lever.

The levers have been plotted on a larger scale in Fig. 16, which gives a clearer representation of the vessel's varying condition of stability, the upsetting levers being shown below the horizontal line and the righting levers above. The angle at which the vessel comes to rest—or angle of steady heel—is seen to be 39 degrees, and a corresponding waterline has been shown dotted in Fig. 15. This, of course, is an alarming angle of heel, as it results in the vessel's decks being absolutely unfit for traffic, and serious interference with the launching of the boats to the extent of preventing many of them being launched at all. A better idea of the vessel's condition is given by Fig. 17, where the vessel is shown in the inclined position of 39 degrees.

It must also be remembered that the above calculated results are purely theoretical, and if we consider the combination of other possible effects, such as the entry of water through open sidelights into the remaining undamaged portion of the vessel, bad weather, etc., we must conclude that this calculated position is the most favorable possible, and even one which is extremely unlikely, and, further, that very few boats would be filled and launched before the critical inclination occurs.

Centerline longitudinal bulkheads are therefore a grave danger in a vessel of this class and in the event of such an accident as that described. Even without such bulkheads, and the vessel sinking by the head as described in the earlier portion of this example, there would be much better chances of the boats being all filled and launched before foundering, as the changing of trim would not have the detrimental effect as occurs owing to the change in inclination.

Of course, in vessels of this class it is not usual to have a combination of purely transverse and longitudinal centerline bulkheads; but it is more usual to fit watertight wing bulkheads forming side bunkers. In such a case we would probably have a centerline bulkhead extending from bulkhead "A" to bulkhead "C," and wing bulkheads extending from "C" to the after end of the boiler room, as shown in Fig. 18. In this case there would not be such a large amount of lost buoyancy, provided the starboard wing bulkhead remains intact, and the movement of the center of buoyancy to port and resultant inclination would be slightly less than with the centerline bulkhead extending over the whole length of the damaged space, although, of course, the amount of heel would still be highly dangerous.

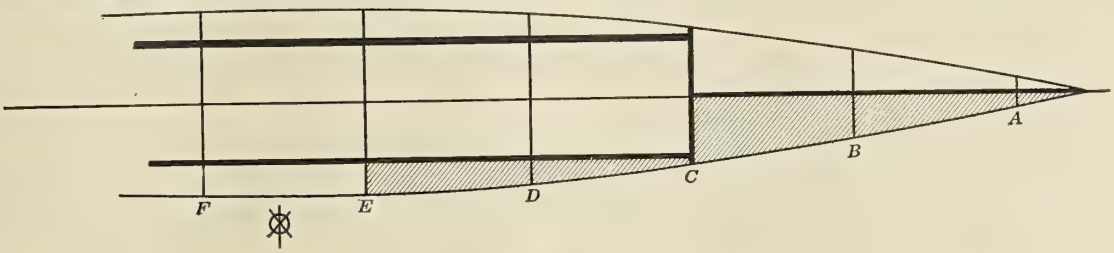


Fig. 18

To complete this example we will now consider the effect of a perfectly watertight deck fitted in such a vessel. So as to place the fullest reliance on such a deck it must be absolutely intact all fore and aft and having metal-to-metal connections in its construction and calked watertight; all hatchways should be trunked and watertight to, at least, the upper deck. Such a condition will be presumed in this portion of the example.

The deck to be made watertight should be one situated at a reasonable height above the load waterline, so that any damage of this nature will have as small a chance as possible of extending to the watertight deck and at once impairing its efficiency.

In the present case, deck D is the one taken as being watertight. We have previously seen that the amount of lost buoyancy is 12,765 tons, and the net area of the remaining intact waterplane is 33,665 square feet, which gave a resultant mean sinkage of 12.46 feet, giving a new mean draft of 42.46 feet. The first effect of the watertight deck will be to reduce this amount of mean sinkage, because of the intact buoyancy lying above the deck being quite unaffected by the damage to the lower portion of the hull.

The mean height of the watertight deck in way of the damaged compartments is 39.5 feet above keel, and up to this point the area of a "damaged" waterplane would be used in determining the sinkage or to obtain the amount of buoyancy which is regained during immersion; after this point is passed, owing to the intactness of the buoyancy above the watertight deck, the full area of the waterplane must be used.

We should therefore first ascertain the amount of regained buoyancy at a draft of 39.5 feet. This, of course, represents a mean sinkage of 9.5 feet at this point, and by using the area of a "damaged" waterplane at half depth of this sinkage, the amount regained can be found as follows: 35,235 square feet (area at half depth) $\times$ 9.5 feet (depth) $\div$ 35 = 9,566 tons of buoyancy regained at the point where the mean height of watertight deck enters the water; 12,765 — 9,566 = 3,199 tons, still to be made up by further immersion. Dividing this remaining amount by the full area of the waterplane (undamaged) we will obtain the additional amount of immersion required.

$$\frac{3{,}199 \times 35}{52{,}410} = 2.14 \text{ feet additional immersion;}$$

39.5 + 2.14 = 41.64 feet, which is the new mean draft in the damaged condition, but having the deck D perfectly watertight.

The trim may now be investigated, and in this respect it will be at once noticed that, as the new mean waterline at 41.64 feet draft passes through perfectly intact buoyancy, the question of trim is in this case quite equal to the normal, there being no damage effect of waterplane to take into account.

The center of flotation of the 41.64 feet waterplane is 7.8 feet aft of amidships, and the longitudinal metacentric height, corresponding to a perfectly intact waterplane, is 1,265 feet. The moment to change trim 1 inch is therefore

$$\frac{40{,}500 \times 1{,}265}{800 \times 12} = 5{,}337 \text{ foot-tons.}$$

Before the trimming moment can be ascertained the center of buoyancy of the new added layer must be found. We have already dealt with this layer in two portions—one, the lower, which is itself affected by the loss of buoyancy, and the upper, which is entirely composed of undamaged buoyancy. The former represents 9,566 tons, and has its center 81.2 feet aft of 'midships, while the latter contains 3,199 tons, and has its center at 7.7 feet aft of amidships. The two portions of the layer can now be combined and the center of buoyancy of the whole layer of sinkage found:

$$\begin{array}{llr} 9{,}566 \text{ tons} \times 81.2 \text{ feet aft} & = & 776{,}759 \\ 3{,}199 \text{ tons} \times 7.7 \text{ feet aft} & = & 24{,}632 \\ \hline 12{,}765 & & 801{,}391 \end{array}$$

$$801{,}391 \div 12{,}765 = 62.8 \text{ feet aft of 'midships.}$$

Now, seeing that the 12,765 tons of lost buoyancy originally contained in the damaged portion of the ship between bulkheads A and E, and having a center of gravity at 167 feet forward of 'midships, is to be compensated by means of the addition of an equivalent amount in the layer of immersion, but having its center of gravity at 62.8 feet aft of 'midships, the effect will be equal to a trimming moment of 12,765 $\times$ (167 + 62.8) = 2,933,397 foot-tons. This trimming moment divided by the $M.\ C.\ T.\ 1''$ gives the total amount of trim: 2,933,397 $\div$ 5,337 = 550 inches of trim. Distributing this trim in accordance with the position of the center of flotation of the 41.64 feet waterplane, we have

$$\frac{550}{12} \times \frac{392.2}{800} = 22.47 \text{ feet decrease of draft aft owing to trim.}$$

$$\frac{550}{12} \times \frac{407.8}{800} = 23.36 \text{ feet increase of draft forward owing to trim.}$$

41.64 — 22.47 = 19.17 feet, new draft aft.
41.64 + 23.36 = 65.00 feet, new draft forward.

The waterline corresponding to these new drafts is shown in Fig. 14 by $W_3\ L_3$, and it will be seen that there is an enormous difference between this and the condition produced in the earlier portion of the example when no watertight deck was allowed for.

In spite of the serious damage, which has been presumed throughout this example, it will be seen that in the latest case the watertight deck has been the means of restricting the flooding so as to leave the vessel with quite a reasonable amount of reserve buoyancy as against certain foundering when without the watertight deck. A freeboard of about 22 feet to shelter deck remains, and which alone is ample proof of the effectiveness of the deck. The trim is, of course, abnormal, but in any case it is assured that the vessel will remain afloat and allow the passengers and crew being transferred, which is more than can be safely said in the case taken without the watertight deck, or should a list occur owing to central division by means of watertight vertical bulkheads fitted longitudinally. Further than this the vessel is in a condition permitting salving; the remaining freeboard will allow of the aftermost hold compartment being flooded up to the upper B deck so as to decrease the trim by the head. Although this would cause an additional mean sinkage of about 3 feet, there would be a total change of trim equal to about 22½ feet, so that the drafts would be amended to about 33½ feet aft and 56½ feet forward, in which condition there would be reasonable hope of the vessel steaming into sheltered waters to there permit of the damage being attended to, there still remaining a freeboard of 19 feet.

It is therefore seen that the perfectly watertight lower deck, dividing the vessel horizontally into two absolutely independent portions, is the most valuable means of watertight subdivision fitted in conjunction with transverse vertical bulkheads. With such a system the public would be able to safely accept a guarantee of unsinkability.

Type of Boats for the New York State Barge Canal.—In a report just issued by John A. Bensel, state engineer and surveyor of New York, outlining the types of boats best adapted for the navigation of the new state barge canal, it is stated that the largest number of vessels will be for fleet service. They will be about 150 feet long and 22 feet beam, a size which permits the lockage of four at a time, one of the four being a power boat towing the other three. Another type of boat that will be used will be about 300 feet long with a beam of 40 to 43 feet. This type will probably be used for service on the Great Lakes. Mr. Bensel states that in vessels having a length of 300 feet, freight will be carried cheaper through the canal than in boats of smaller size.

Economical Method of Handling Freight

Electric Storage Battery Trucks Installed by the Fall River Line Eliminate Congestion and Reduce the Cost of Handling Miscellaneous Package Freight

At piers 14 and 15, North River, New York city, which form the New York terminal of the New England Steamship Company, which operates fast passenger and freight steamships to Fall River, Mass., and Providence, R. I., an average of 2,300 tons gross of miscellaneous package freight is handled to and from the steamship company's vessels each day. The boats usually dock at the New York piers at about seven o'clock in the morning and leave again on the east-bound trip at half-past five or six o'clock in the afternoon. During the interval while the boats are at the piers, the entire west-bound freight must be unloaded and a complete cargo for the east-bound trip loaded on the boats. Until recently this freight was handled by hand trucks, and, on account of the increasing volume of freight handled, congestion on the piers resulted. Within the last year, however, this situation has been relieved by the installation of twenty Sprague electric freight trucks, by means of which it has become possible to keep the shippers' trucks off the pier and to load and unload the freight in much less time and at less cost than was possible with the former methods.

The Old System

With the old system, in order to keep the cost down to a minimum, it was necessary for nearly all of the shippers' trucks to go on the docks to receive or deliver freight. Those receiving inbound freight were driven to the point where their freight was stowed and were loaded direct from the pile of freight, except in cases where the dock was too congested to permit the shippers' trucks to drive to their freight without a long delay. In such cases, which were not infrequent, to give the shippers satisfactory service it was necessary to truck the freight by hand to the shippers' truck at the bulkhead. This required a number of extra men, and was very expensive to the company. The shippers' trucks delivering outbound freight were also driven on the dock to the gangway of the ship, where the freight was unloaded, weighed, checked and trucked direct to the deck of the ship by hand trucks. The number of shippers' trucks allowed to unload at one time economically was limited by the space directly in front of the gangway.

At certain times of the day, when the shippers' trucks were arriving at the dock in greatest numbers, in order to avoid too many trucks accumulating, which would cause a long delay to the shippers' trucks and a great congestion both inside and outside of the dock, it was necessary for the company to give the drivers help to unload their trucks quickly, and it also necessitated a large number of men with hand trucks to truck the freight on the ships, as there was no space available to pile the freight temporarily on the dock. Even when conditions were the best a trucker could handle but a small load, while at the time of high tide the grades up the gangways was such that the trucker required assistance.

Advantages of the Electric Truck

With the installation of electric trucks, however, this delay due to congestion has been reduced to a minimum, if not entirely eliminated, and a great reduction has been made in the cost of handling the freight by keeping the shippers' trucks delivering outbound freight off the docks entirely. As a rule, an average of 863 trucks a day delivered freight for the Fall River boat, and nearly as many delivered freight for the Providence boat. To handle this volume of freight in the limited time available without causing congestion, several changes were made in the method of receiving freight, in which the use of electric storage battery trucks formed a most important part.

Fig. 1.—Electric Trucks Delivering Freight on Steamer from Receiving Platform

Fig. 2.—Sprague Electric Truck Ascending Steep Grade With Load

The first notable change consisted in the construction at the bulkhead of the pier of a receiving platform one inch lower than the loaded electric truck. On this receiving platform is delivered from the shippers' trucks all of the outbound freight for both the Providence and Fall River boats. The platform is built in sections; the outer section, or that nearest the doors, is permanent and contains two scales at each door. The inner section is portable and is subdivided into five sections so as to make it possible to lift them out of the way when not in use. In the early morning these portable sections are lowered and the outbound freight received is stowed on them, after it has been weighed and checked. Meanwhile the electric trucks are engaged in unloading the ships.

Receiving Platform

As the freight is transferred across the receiving platform, it is sorted according to railroad divisions, so that

each electric truck can be given a full load of freight to be stowed in a certain section of the boat. For instance, on the Fall River boat the forward end of the deck on which the freight is stowed is reserved entirely for freight destined for Fall River; aft of this, at either side of the boat, are sections reserved for freight destined for way points beyond Fall River; further aft, space is reserved for carload shipments and merchandise for Boston, while separate spaces are reserved for perishable freight for both Boston and Fall River. Another section of the deck, close to the gangways, is reserved for freight bound for Newport. By loading the boats in this way, the freight may be quickly transferred to trains at the other end of the line.

By the time the portable section of the receiving platform is filled with outbound freight a sufficient amount of inbound freight has been unloaded from the ship and stowed on the pier to make room for stowing outbound freight on the ship, and then, while most of the electric trucks remain unloading the ship, a few are assigned to transfer the freight from the receiving platform to the ship as fast as it is received. No special effort is made to transfer the freight accumulated on the platform until the ship is nearly or completely unloaded. As soon as a portable section is unloaded it is hoisted out of the way and the freight loaded direct on the electric trucks.

In the morning hours the outbound freight is not delivered as fast, and can be easily received at one or two doors at a time at the receiving platform without causing delay to the shippers' trucks, but as the day goes on the shippers' trucks accumulate faster, and when they cannot be taken care of by the doors already open, extra doors are then thrown open so that the shippers will be permitted to unload their trucks without delay. As many as twenty trucks can be unloading their freight at the same time when all the receiving doors are open. At either end of the platform is a receiving door without a platform to receive full load shipments direct from the shippers' trucks to the electric truck. This is to avoid the handling of freight across the platform which does not require weighing.

Fig. 3.—Stowing Freight on Steamer

Fig. 4.—One Electric Truck Load Equivalent to Twelve Hand Truck Loads

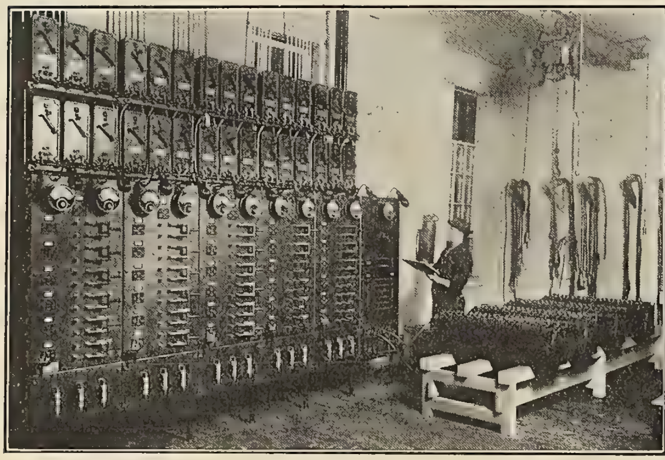


Fig. 5.—Charging Board for Storage Batteries

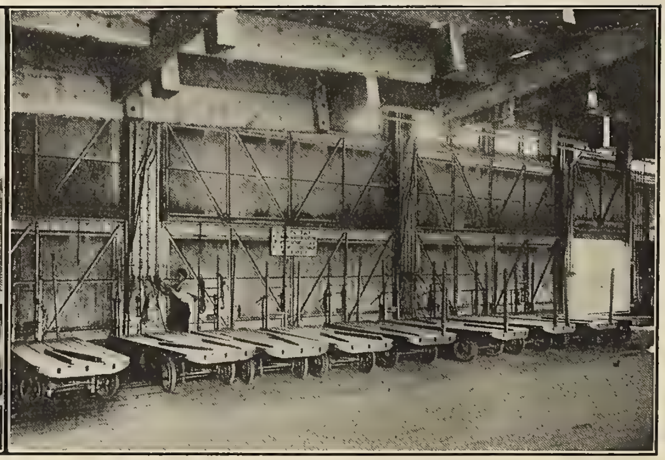


Fig. 6.—Freight Trucks Being Charged

In unloading the ship the electric truck is loaded with freight with little regard to marks or destination. This freight has to be sorted as it is stowed on the dock, and it is sometimes necessary for the electric truck to go to a number of piles of freight in order to distribute its load in the proper places on the dock.

Savings Effected by the New System

It is almost impossible to determine the exact saving effected by the use of these trucks at this time, on account of the wide variation of conditions and the limited time the trucks have been in service, but from the observations thus far made it is safe to say the savings will mount well into large figures. Different kinds of freight are handled on different days, and the tonnage varies to a great extent

Fig. 7.—Sprague Electric Trucks Receiving Freight from Receiving Platform for Transfer to Steamer

Fig. 8.—Electric Trucks Receiving Package Freight Direct from Shipper's Truck and from Platform

at different times of the year. Furthermore, the tides vary each day, more men are available on some days than on others, and there are several other variations, which all have some effect on the actual cost of handling the freight.

As can be seen from Fig. 2, there are times when the grades up the gangway are as high as 25 percent, due chiefly to the tides. Steep grades of this kind, however, can be negotiated by an electric truck with a full load, while with the hand trucks it is absolutely impossible for one man to take an ordinary hand-truck load up such grades. In all classes of freight the electric truck will carry several times the amount that one man can carry with a hand truck, and, furthermore, it will travel three or four times as fast. This is clearly demonstrated in Fig. 4, which shows an electric truck loaded with forty-eight cases of canned goods, and twelve hand-truck loads of four cases each of the same kind of freight.

Another economy is effected when a great amount of freight is to be transferred from barges or lighters to the steamships. By using the electric trucks it is not necessary to warp the barge to the side of the ship, so that the freight can be transferred directly to the ship without a long trucking distance. The barges can be unloaded at any point along the pier wherever they happen to be placed, and the freight can be easily transferred from them to the ship by means of the electric trucks. Finally, a great saving is made in the above method by keeping the shippers' trucks off the docks, and thus making greater space available for storing freight.

Steel Derrick Barges for the Pennsylvania Railroad

During the year 1907 the Pennsylvania Railroad Company built eight steel derrick barges, principally for the transportation of structural material, large pipe and miscellaneous heavy material. Five more barges of similar type have recently been added to the company's equipment, bringing the total number of derrick barges operated by the company up to seventy-two.

In the new barges the hull is formed with a view to easy towing; the corners of the deck have been rounded so as to lessen damage done to piers and other boats while maneuvering, and rounded steel fenders are fitted along the sides for the same purpose. The heel of the boom is stepped ten feet above the deck, so that freight can be piled high close up to the mast, which is of considerable advantage where long structural material is carried. The hoisting ropes lead directly from the mast head blocks to the hoisting engine drums, avoiding quarter blocks, and unusually large sheaves are used to reduce the bending strains in the ropes; the sheaves are fitted with roller bearings.

The hull is entirely of steel, 100 feet long, 34 feet wide and 9 feet 6 inches deep amidships. The hull plates are 3/8-inch thick and the deck plates 3/8-inch thick supported by 9-inch channel bars 2 feet apart. A truss frame is built 6 feet each side of the centerline extending under the deck storage space and distributes the deck strains to the vessel's framing. The only wood used in the construction is the small rail around the edge of the deck to prevent materials falling overboard.

The mast is of the A-frame type without rope back, stays or shrouds. Each leg is formed of two 12-inch channels with plate on one side and lattice bracing on the other; the heel of the mast is carried on three columns of similar construction, extending to the bottom of the vessel, and as the boom heels at the heel of the mast it will be noted that the racking strains are confined to the derrick structure and the supporting columns require no lateral bracing other than that necessary to overcome the small lateral strains imposed when the vessel lists.

The boom is 78 feet long, formed of four angle bars 3½-inch by 3½-inch with plates on three sides and lattice bracing on the under side. The main hoist is a five-part fall of 5/8-inch wire rope with a capacity of 10 tons at 36 feet per minute. The auxiliary hoist is a single part 5/8-inch rope lifting two tons at 180 feet per minute. The hoisting engine is of unusual design; each hoisting drum is located directly beneath the mast head purchase block that it controls and is operated by a single gear reduction from a jack shaft common to all, the jack shaft being coupled

Pennsylvania Derrick Barge

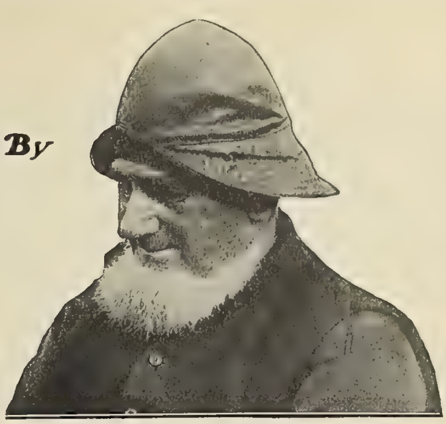
direct to the crankshaft of the engine; the latter is of the double cylinder type, 9-inch diameter, 10-inch stroke. The boiler is of the usual vertical type with 10.5 square feet of grate surface and 330 square feet of heating surface; a pump is installed that will deliver one good size fire stream and has suction pipe connections to each compartment for pumping the bilges.

The refinements incorporated in the design, such as large sheaves with roller bearings, direct leads for the ropes and small number of driving gears, as above mentioned, have all contributed toward the efficiency of the mechanism, and on recent test it was found that 56 percent of the indicated horsepower of the engine was utilized in useful work.

The designs were prepared by the Pennsylvania Railroad Company and three of the barges were built by the Pusey & Jones Company and two by the Ellicott Machine Corporation.

Famous Windjammer a War Prize.—The 3,609-ton steel London ship *Brilliant*, one of the last sailing vessels owned by the Standard Oil Company, found the transition to the German flag an unlucky one. She was recently sold to Hamburg interests, converted into a motor ship at New York, renamed *Perkeo*, and sailed on July 18 for her new home port. On August 5 she was captured by a British cruiser in the English channel and taken into Dover, being probably the first important prize of the great war. The *Brilliant* for years has been engaged in carrying case oil from New York to the Orient, and is one of the best known windjammers afloat.

Economy Talks By "Old Scotch"



Rules for Firing Scotch Boilers

I think when we left off last month we had just quit "rastlin'" with carbon, oxygen and other such stuff that goes into furnaces. I have tried to point out how necessary it is to get these important elements mixed up in the right proportion, and now we must see how it is done practically.

You have seen why it is as important that some air comes in above the grates as it is to have it come in through the grates. I will also suggest right here that it is mighty important not to have too much air, as in that case too great a quantity of oxygen is being supplied for the proper mixture of carbon dioxide and the result is great waste. Some firemen are gradually learning that they must not keep the furnace doors open too long, as that is one of the principal causes of loss of efficiency in coal burning, but if you want to get in on that ten percent rake-off, the first thing to do is get in among your men and train them how to fire properly.

Losses in the boiler room cannot be recovered in the engine room, and if you don't get your money's worth out of the coal in your boiler furnaces you have practically thrown your chances of any part of the ten percent rake-off overboard. Put this up to your firemen at the start.

Suppose you have four three-furnace boilers and three men on a watch, so that each man has to handle four fires. Teach them first that only one fire door must ever be opened at the same time, and secondly that each furnace must be charged in a regular order. Let each one of the three firemen have his furnaces numbered 1, 2, 3 and 4. Call your firemen A, B and C, as that is simpler than Murphy, O'Connor and Maguire, or other names like those. Arrange a system so that at regular intervals A charges his No. 1 furnace, to be followed by B with his No. 1 furnace, and then by C with his furnace of the same number. Let A then charge his No. 2 furnace, and so on right down the line, and keep it up regularly, the time between firings being regulated by the demand for steam from the mill in the engine room.

Don't let them put in more than two shovelfuls of coal at each firing and have them close the door between the two. Tell them to scatter a shovelful of coal uniformly over the surface of the fire, and not to put it all in one bunch. The first man who tries to build up a crown-sheeter so that he can sit down and smoke for ten or fifteen minutes should be drawn and quartered, or given some other light punishment of that sort. If you're running natural draft don't let 'em ever carry the fires over 8 or 10 inches thick, for if you do you'll be turning out more of that bad smelling gas I was telling you about and wasting a whole lot of heat units. If you're running with the blowers on you might let 'em carry the fires a foot thick, but no more.

Don't let any of your Irish giants get too busy with his slice-bar, unless you have pretty rotten coal, and have to bust up a few clinkers with that delicate instrument. There's naturally a whole lot of live coals dislocated and prevented from doing useful work by too much use of the slice-bar.

The fires should be kept as nearly level as it is possible to make them, and to do this they should be leveled off occasionally with a hoe or light rake. If your men get skillful in spreading the coal over uniformly you will not have to use the hoe or rake very much. The main object of keeping the fires level is to avoid holes and places where the air can sneak through easier than at other parts of the surface. Give every particle of air the same amount of work to do in climbing through the burning coal, and then you will succeed in carrying fires which will burn coal economically.

Don't wet the coal down, as many engineers like to have done, in the mistaken idea that it burns better. If the coal is so finely powdered and the draft is strong, it is all right to sprinkle a little water on it, so that the loose particles will not be carried up the stack unburned. If the coal is lumpy have the "snipes" break it up before it is shoveled into the furnaces. You should never use lumps much larger than a baseball, if you know how large that is. Perhaps some of you will understand it better if I say a highball.

If the fires are not being forced very strongly, pull the lumps out of the ashes and burn them over again, as there is often a lot of good fuel thrown away through the ash ejector.

It isn't necessary maybe for me to tell you to have the fires cleaned, and that this operation should be done as rapidly as possible in order to keep as much cold air out of the furnaces as you can. Don't stick too closely to any regular time for cleaning fires, but clean them when it is plain that they need cleaning. Don't under any circumstances clean more than one fire at a time. Above all things, don't let ashes collect in the ash pans; keep them hauled and clean all the time. If you don't the air does not have a chance to get at the backs of your fires, and it is mighty important that the fires at the backs of the furnaces burn as brightly as in the middle or front. Keep in mind all the time that the great economy in fuel is to burn it properly.

These rules that I have laid down may sound a little school-boyish, but it is in carrying them out properly that you will save coal, and coal means money, both for the owners and yourselves. In the next chapter I am going to inflict upon you some more suggestions about combustion, and then proceed with some other ideas for economy about the boilers. You must remember that it is the little details in connection with your business where savings are to be made.

Yours for Economy,

Old Scotch

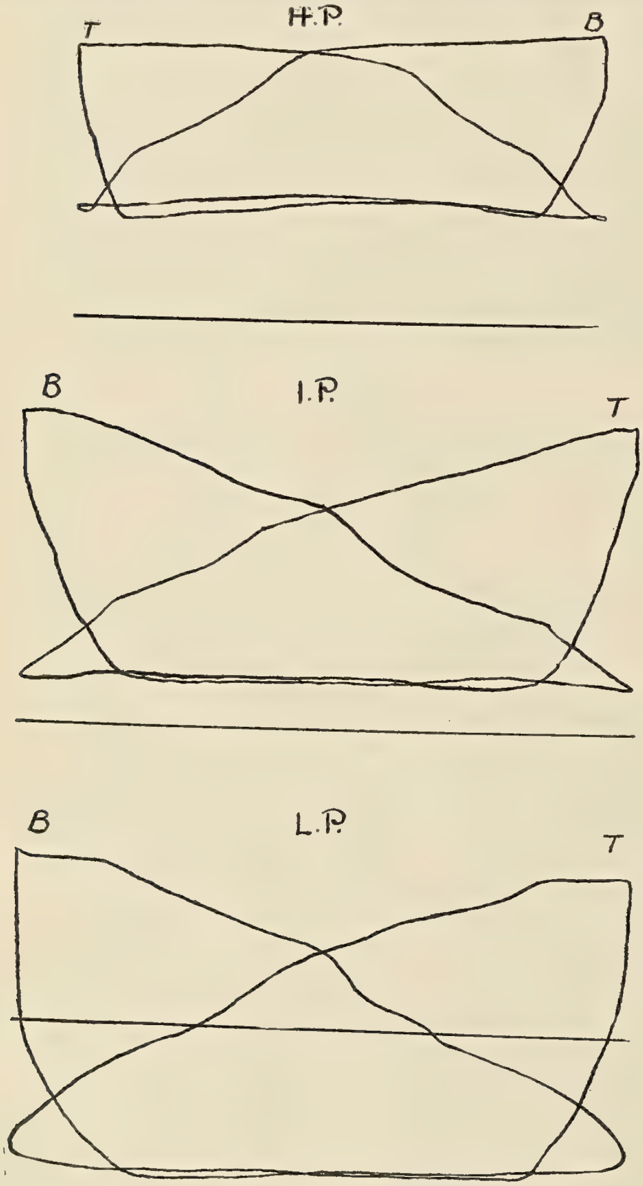
Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department—Indicator Cards from Marine Engines will be Analyzed and the Horsepower Calculated, Provided Complete Data Are Sent with the Cards

CONDUCTED BY H. A. EVERETT*

Q.—Enclosed is a set of indicator cards from a triple-expansion engine. I want to know what power the engine is developing and what defects the cards show? S. M. C.

A.—The calculation for power is tabulated below. In general the cards are not bad, but the distribution of power should be improved. The high-pressure is under-



Indicator Cards from Triple Expansion Engine (Not Full Size)

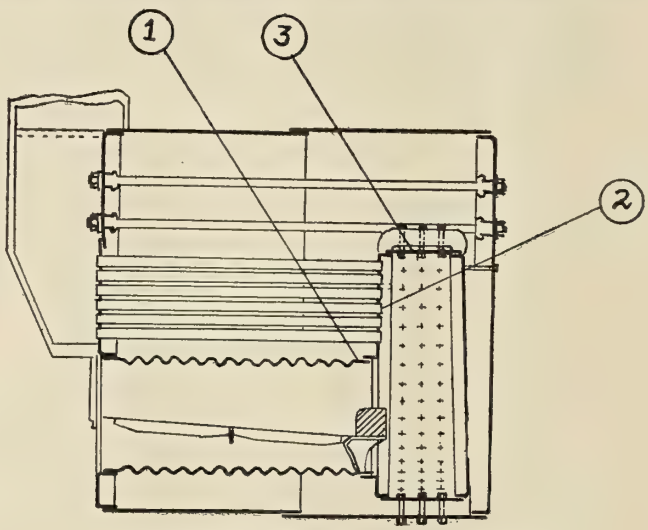
powered, and since release in this cylinder occurs too early, as evidenced by the loops in the toes of the cards, its power would be increased by working the high-pressure gag so as to delay cutoff a trifle more. As cutoff is early in the intermediate, it would be well to link up the whole engine a bit before working the gags. A good scheme is to take cards and without removing them from the indicator drums, take other cards superposed on them after changes of this sort have been made, so that the effect can be traced. *Change only one thing at a time.* The curved exhaust line of the high-pressure card indicates either leakage through the valves or restricted receiver space.

		Area Sq. In.	Length Inches.	Spring Lbs. Per In.	M. E. P.	Area of Piston Sq. In.	I. H. P.	I. H.P. Per Cyl.	I. H. P. Total.
A H.P.	TOP	2.25	3.19	100	70.5	415.5	242		
A H.P.	BOT	2.24	3.19	100	70.3	395.9*	230	472	
A I. P.	TOP	3.24	3.74	40	34.6	1075.2	308		
A I. P.	BOT	3.14	3.74	40	33.6	1055.6*	294	602	
A L. P.	TOP	4.18	3.71	10	11.3	3019.1	282		
A L. P.	BOT.	4.20	3.71	10	11.3	2999.5*	280	562	1636

*5-inch piston rod assumed.

Q.—What parts of a Scotch boiler should be examined first for deterioration, and what kind of defects should be looked for? T. JONES.

A.—The following tabulation gives a list of the commonly inspected portions of Scotch boilers with the character of defects frequently found at these places. Leav-



Parts of Boiler Where Deterioration Occurs

ing out of consideration deterioration by pitting and scale which may be erratic, one would expect the normal deterioration of a boiler to first show up in the three places first mentioned in the table.

PART	DETERIORATION COMMONLY FOUND.
Top of furnace where it joins combustion chamber (1) in figure.	Burning away, cracks, scale, grooving.
Back ends of tubes (2) in figure.	Burning away.
Top of combustion chamber under girder stays (3) in figure.	Burning away; fractured stays; deformation.
Back of combustion chamber.	Scale.
Furnaces (general).	Scale on crown. Pitting and longitudinal cracks along line of fire bars. Transverse cracks along corrugations; distortion.
Tubes (general).	Pitting, cracks, scale.
Joints and seams.	Leakage.
Front connection.	Distortion.

*Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

Q.—If I know the steam pressure carried and the amount of coal burned per hour in the boilers of a ship, how can I calculate the size of the steam mains? ENGINEER.

A.—The size of the steam main is a function of the speed at which it is allowable to have steam pass through the pipes. Good marine practice permits a speed in the main steam pipe of about 8,000 feet per minute. The volume of the high-pressor cylinder at cutoff multiplied by twice the revolutions per minute will give the total amount of steam passing through the main steam pipe. Dividing this by 8,000 gives the area which the steam pipe should have; commonly the entire volume of the high-pressure cylinder instead of volume up to cutoff is used. For example, an engine with a 25-inch high-pressure cylinder by 48-inch stroke at 75 revolutions per minute will require a main steam pipe with an area of

$$\frac{3.4 \times 4 \times 2 \times 75}{8{,}000} = .256 \text{ square feet}$$

Diameter = $6\frac{7}{8}$ inches.

Q.—What method should be used for determining the size of a feed pump required to feed boilers of a given size? L. P .S.

A.—Lloyd's Rules require that ships are to be fitted with two feed pumps, each capable of supplying the boilers; and a conservative working rule is to make each pump of such size that its rated capacity when working at the upper range of its speed shall be twice the normal evaporation of the boilers.

Q.—Assuming two boilers of the same dimension with an equal grate area, one carrying 100 pounds and the other 160 pounds pressure, which would require a larger safety valve, and why? L. P. SHONTS.

A.—The General Rules and Regulations of the Board of Supervising Inspectors of the United States give the following formula for the required area of all safety valves:

$$\text{Formula: } a = .2074 \times \frac{W}{P}$$

where a = area of safety valve in square inches per square foot of grate surface; W = pounds of water evaporated per square foot of grate surface per hour; and P = absolute pressure per square inch = working gage pressure + 15, so that assuming boilers of equal grate area and equal evaporation per square foot of grate surface per hour, the boiler carrying steam at 100 pounds pressure would require a larger safety valve than the one carrying steam at 160 pounds pressure. The reason is that the specific volume of steam at 100 pounds is greater than at 160 pounds in the approximate ratio of $\frac{160}{100} = 1.6$, so that to blow off the *same amount of steam* with the *same allowable velocity* through the valve, we should need an area greater by this proportion for the boiler carrying steam at 100 pounds.

Q.—I have two Scotch boilers, 11 feet long, 12 feet diameter, with three furnaces in each boiler, 8 feet long by 38 inches diameter. The length of the grate is 6 feet. What drop should be given the grate bars and would it be wise to lower the front end of the grate bars also? A. A. McM.

A.—The slope of the grate bars should be about ¾ inch to 1 inch per foot. If the grate is over 5 feet long there is generally some difficulty in stoking the back end of the fire. The slope helps to overcome this trouble and, at the same time, the fire is better supplied with air at the back, and is not choked by the products of combustion from the front.

The area over the fire-bridge at the back end of the grate should be about one-sixth of the grate area, and the height from the bridge to the top of the furnace about 40 to 45 percent of the furnace diameter. The fire-bridge is generally about 5 inches to 8 inches above the level of the grate at the back end.

For a furnace 38 inches in diameter having a grate 6 feet long, the above rules would place the top of the fire-bridge about 3 inches above the centerline of the furnace, the grate bars at the back end would be about 4 inches below the centerline, and a slope of ¾-inch per foot would place the front end of the bars about ½ inch above the centerline.

Q.—What is the difference between tonnage and displacement? M. O.

A.—*Tonnage* is intended to serve as a measurement of the internal capacity of the vessel, and for this purpose the arbitrary unit of 100 cubic feet is adopted as equal to one ton. A ton in this sense means nothing other than 100 cubic feet of interior space.

Displacement is the volume of water which the ship displaces when floating and the weight of the displaced water is equal to the weight of the ship. Thirty-five cubic feet of sea water weigh one ton, so that a ton for displacement calculations is thirty-five cubic feet.

Freight Handling Appliances at Marine Terminals*

Within the past two years the problem of package freight handling by mechanical means has received the attention of railroad and steamship companies, the manufacturers of mechanical handling appliances and public boards interested in terminal construction. Development has been principally along two lines, the overhead and the surface system, though a third, the conveyor system, has received some consideration. The conveyor system, while perhaps well adapted to certain special conditions, is believed to be not sufficiently flexible to meet the complex requirements of a typical marine and railway terminal.

STORAGE BATTERY TRUCK

The storage battery truck has been introduced and has found favor in several terminals. It takes the place of the old hand truck, making it possible for a man to travel faster and with a much heavier load, hence reducing the cost of transportation but not otherwise affecting the problem of hand labor. This truck has the advantage of easy introduction into old terminals, requiring only a reasonably smooth floor. Like the hand truck, it can enter box cars and ships having side hatches.

In this connection may be mentioned the inclined elevator which has been introduced at a few marine terminals for carrying loaded trucks up a steep grade. The storage battery truck carrying a light crane has also been introduced, but up to the present time has not found a broad field of usefulness.

OVERHEAD MONORAIL SYSTEM

The overhead monorail system is being pushed by several manufacturers and is looked upon favorably by many interested in terminal development. It is not a new device, but is rather the application of an old device to a new field, for it has long been used to a limited extent in industrial plants. Its introduction into the field of freight handling has resulted in some interesting improvements, especially in track and track switch systems.

Ingenious devices have been worked out for throwing the switch to the desired position and automatically plac-

* Extract from report on Hoisting and Conveying, presented at the annual meeting of the American Society of Mechanical Engineers, New York, December, 1913.

ing a stop at the open track end by the approaching trolley. One system lately introduced avoids the use of any moving part in the switch steering mechanism carried by the trolley, enabling the operator to take any desired course through the switch without stopping.

An overhead system which has been used to some extent in Europe and which has its advocates in this country employs what is termed the gliding switch. It has a curved switch member which slides along the main track. It permits a trolley to pass from the main track to the traveling cross track at any position. This switch is, as far as the main track is concerned, a derailing device. It is believed by the Committee that no installation of this type has been made on this side of the Atlantic.

Several installations of monorail systems for handling package freight have been made in this country, one at the Baltic terminal, New York, in 1912, which handles freight both ways between vessels, warehouse, and a freight shed alongside a railway track. The system passes over streets and tracks at a suitable elevation so as not to hinder in any way the traffic on the ground level.

Advantages and Limitations

In the present development stage, the storage battery truck and the monorail overhead system appear to be competitors for the field. Certain advantages and limitations of each are recognized. The battery truck as mentioned above will enter box cars and side ports of ships. It will go anywhere a smooth floor is provided, but it will only transport and will not hoist.

The overhead system involves greater initial cost. The trolley will go only where track is provided and will not enter box cars, but it will serve flat cars and may reach out over a ship, serving any hatch or the dock without regard to level as affected by stage of tide. It will hoist as well as transport, thus providing a means of transferring freight from one floor to another, and with the traveling cross track will serve areas and tier freight. The monorail trolley affords higher speed of travel than the battery truck. As it does not require clear floor space for a roadway, more floor is available for checking, storage, etc., and the capacity of the terminal materially increased. This increase in capacity should in a great measure, and perhaps fully, justify the greater outlay. It is probably a safe prediction that the two systems, the overhead and the surface, will supplement each other, though different local conditions may sometimes control.

Co-operation between railroads, steamship and dock companies, and machinery manufacturers is absolutely essential to the best results in the development of devices for the mechanical handling of freight. Modifications and improvements in the organization and management of terminals must of necessity be made coincident with the installation of the hoisting and conveying appliances in order that such machinery may best serve its purpose.

In the past year the mechanical handling of lumber has received considerable attention. This is particularly true on the Pacific coast, where extensive preparations are being made for handling the large increase in business that is predicted will result from the opening of the Panama Canal.

Handling Lumber

The unit system of handling lumber is becoming more and more general. By the unit system is meant the sorting and stacking of lumber in uniform units which may be separated by skids or chocks, and one unit or package handled at a time. Modern hoisting and conveying appliances are equipped with automatic grapples so that these units may be picked up or deposited by the operator in the hoist. The units will range from 3 to 8 tons.

In this work the monorail man trolley has been a recent and important development. The locomotive crane has also found a field in this branch of industry and in some cases the locomotive crane of the portal pier type is needed, so that freight cars may pass between the legs of the cranes and be loaded and unloaded by it. This type of crane is designed to travel along the face of the dock for handling lumber directly to and from boats, and by means of a transfer table the crane may be switched to branch tracks for the handling of lumber to and from storage piles.

Probably the most radical development in the lumber handling industry is that which the C. A. Smith Lumber Company, of California, have undertaken. The unit system is employed and the lumber is handled by various types of cranes. Cantilever cranes are used on the dock face for loading specially constructed vessels for the trade, which enable the large 8-ton units of lumber to be stowed intact. This means of direct handling of large units, and the development of special vessels to facilitate handling most nearly approach the history of the development of the coal and ore handling business on the Great Lakes.

Transshipment at Sea

Two novel forms of cableways have reached their perfected stage during the year 1913. Both of these are for use on the high seas, one for transshipping coal, ammunition and supplies to warships in mid-ocean under headway, and the second for transshipping persons from a wreck to a life-saving ship.

The apparatus for coaling at sea has been under development for over ten years, but not until the last year, and since the newly developed automatic tension engine has been added, can the marine cableway for coaling at sea be regarded as a complete solution of the problem. During recent tests at sea a collier, while rolling 20 degrees in a driving storm, transshipped 83 tons of coal in an hour to a battleship 400 feet astern of the collier while both were proceeding at a speed of about 7 knots.

The life-saving machine comprises the old-fashioned breeches buoy apparatus, in common usage along the coast, in connection with a small-sized automatic tension engine serving to wind in and pay out the main supporting cable or hawser serving as a trackway for the passage of the breeches buoy from ship to ship.

Opening of the Panama Canal

With little ceremony the Panama Canal was officially opened for the traffic of the world on August 15 by passage of the United States War Department steamship *Ancon* from deep water on the Atlantic side to deep water on the Pacific side. The vessel which has been leased to the Panama Railroad for service between New York and Colon, left Cristobal at 7 o'clock in the morning with many notable people on board, including officials of the Canal Zone, and arrived at Balboa, at the Pacific end, at 4 o'clock in the afternoon, making the passage in nine hours. The passage through the Gatun locks, which have a lift of 85 feet, was made in seventy minutes. The ship had a full cargo on board, so that the passage could be made with a ship at full load draft. Earlier in the month an experimental voyage through the canal was made by the steamship *Christobal,* of the Panama Railroad & Steamship Company, the passage from the Atlantic to the Pacific being made in 11½ hours and the return trip in 8½ hours.

Letters from Practical Marine Engineers

A Department for the Readers' Discussion of Ideas Relating to the Design and Handling of Marine Engines, Boilers and Auxiliaries, Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

A New Trick in "Trick" Valves

The compound engines of a tug had undergone certain repairs, one of which was the fitting of a cast iron liner in the high-pressure cylinder, so that, with the same propeller the power delivered would be less according to the heating surface of the boiler, which had been too small as first designed. A new high-pressure slide valve was fitted, and, in order to reduce the wear and tear and thus decrease the driving power required by it, an arrangement as shown in Fig. 1 was used. The relief frame over the valve had ports cut in it corresponding with the ports to the cylinder, and two holes were formed through the steam passage, as shown, to allow steam on both sides of the valve and thus balance it. For the greatest part of travel this allowed only exhaust steam, however, to the back of the valve to balance the initial pressure on the face of the valve.

Even on the first trip with this arrangement the coal consumption was noticeably increasing, which it continued to do for six months. During this time the engineers had tried several remedies, such as altering lead, cut off, release and compression. The writer was then consulted and immediately decided that the relief arrangement did not relieve the valve, and promptly designed a new valve, as shown in Fig. 2.

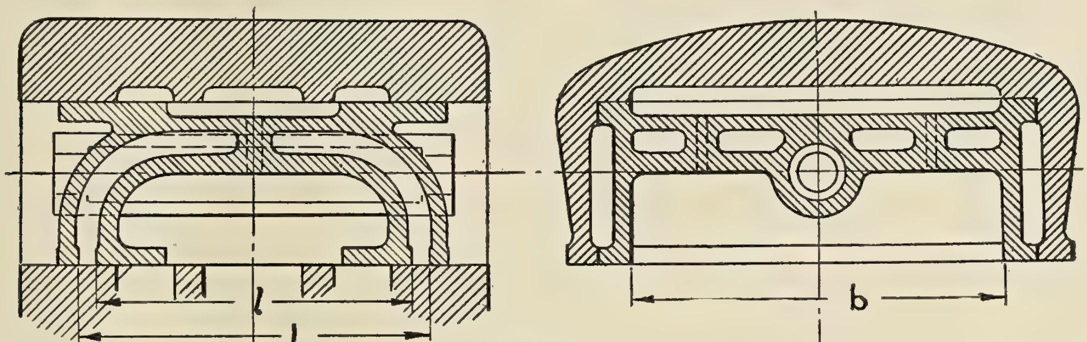


FIG. 1

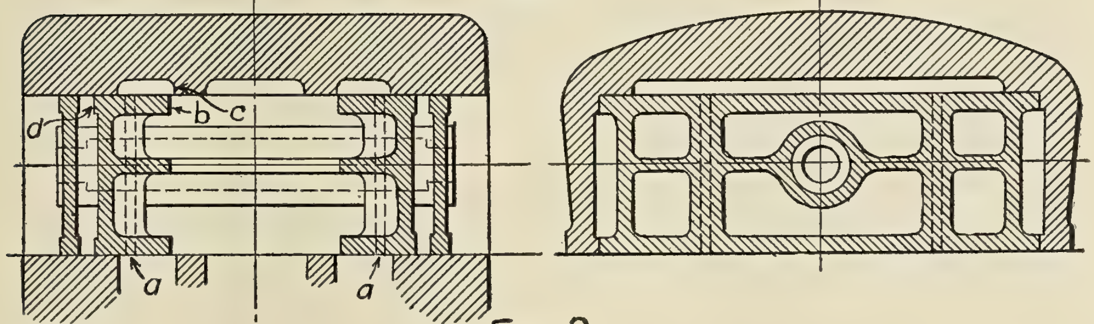


FIG. 2

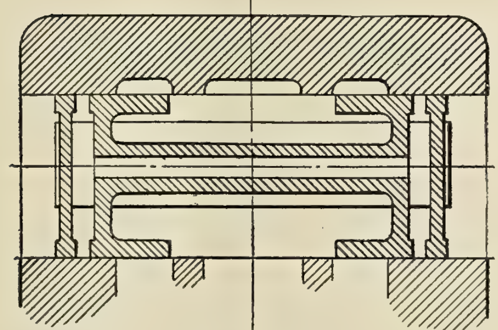


FIG. 3

In Fig. 1 it can be seen that the upward pressure which should be overcome is the initial pressure of the steam $\times (L - l) \times b$. The new valve allows steam to enter both edges and by means of the small holes, *a*, keeps the whole perfectly balanced in all positions. The small holes, *a*, give communication for balance after *b* passes *c* and until *d* gives communication.

The new valve had the desired effect of decreasing coal consumption, which after half a year had increased to about 20 percent more than with the old valve. The leaking and water consumption had also increased until the feed pump, which had never given trouble, could not deliver sufficient water to the boiler. With the valve in Fig. 2, however, these troubles were eliminated.

In concluding, the writer would suggest that in designing a trick valve with a relief frame the designer use some arrangement similar to Fig. 3, in which the opening and closing of the admitting edge will be at four different points at the same time, and the whole valve will be relieved from pressure in every position. This was not used in the above case, as the clearance necessary was too great.

D. K.

Poorly Designed Eccentrics

During the maiden voyage of the new steamer "F" between London and Tokio serious trouble was experienced because of a poorly designed eccentric sheave. The low-pressure ahead eccentric strap became hot, but as the rise in temperature was not serious and as the same thing had happened on the trial trip, there was not much anxiety felt by the engineer. This was only a few days out from London, however, and when the Mediterranean was reached the temperature became so high that relining of

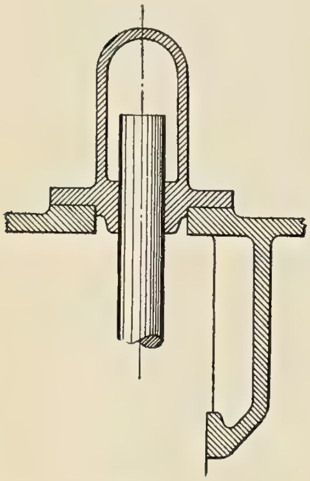


Fig. 1

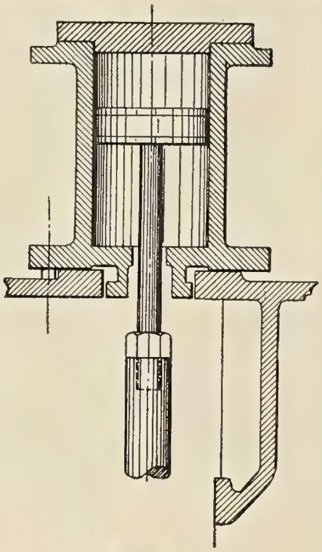


Fig. 2

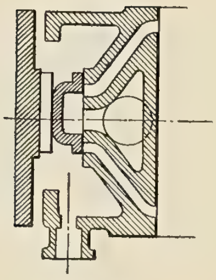


Fig. 3

the strap was necessary. The new white metal acted in the same manner and lasted only a very short time. It was then quite evident that in designing the strap it had not been made wide enough to account for the friction caused by valve friction, weight of valve, rods and link and the forces brought into play by the motion of the whole, particularly the acceleration forces and weights.

In order to take care of these forces, then, a balance cylinder would have to be used, but to make such a thing at sea would have been impossible. The first engineer, however, conceived of the idea which finally accomplished the required results.

He took a steam cylinder from one of the winches and by proper fittings and adjustments used it on top of the valve chest as a balance cylinder. The valve rod as designed projected through the chest and was guided in a brass bush as shown in Fig. 1. This bush was taken away and the studs by which it was connected to the chest were cut off and riveted over so that the flange would present a flat surface. The end of the valve rod was cut off to shorten it the required amount, so that when set up as in Fig. 2 the piston would not touch the cylinder head when the valve is at the top of its travel. A hole was then bored in the end of the rod and tapped to take the end of the piston rod of the winch cylinder, which was screwed in and fastened with a checknut, as shown in Fig. 2. New holes were bored in the flange of the valve chest to correspond to the holes in the winch cylinder flange and studs were fitted to join the two. The neck bush and gland were taken from the winch cylinder stuffing box and the whole arrangement set up and packed. The steam in the low-pressure valve chest had free access to the underside of the piston in the improvised balance cylinder, and by setting the steam valve in the winch cylinder, as indicated in Fig. 3, any steam that found its way to the upper side of the piston was led off to the exhaust and out by means of a one-inch copper pipe which led the steam to the condenser.

The engine was started after everything was assembled as outlined, and it remained running while the ship was moored for a day, until it was concluded that the improvised cylinder had the desired effect. The journey was then continued and no further trouble was experienced. In Tokio the winch cylinder was taken off and reassembled as a winch to be used in loading and unloading, after which it was again used as a balance cylinder, and acted very ably in that capacity for the remainder of the voyage. Upon arriving at London a new balance cylinder, well designed for the purpose, was installed and the winch cylinder returned to its proper place. Engineer.

A Leaky Cylinder

The compound engine of a certain steamer had been converted into a triple expansion engine by introducing an intermediate cylinder. It was necessary to bush the high-pressure cylinder to decrease its diameter. This was done by inserting a close-fitting bushing and reboring so that a liner one inch thick was left in the cylinder. This

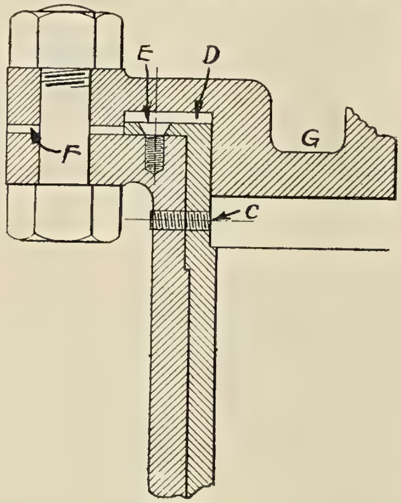


Fig. 1

bushing was flanged at the top and secured by flush dowels at *C*, Fig. 1, and at similar points around the bottom of the cylinder. It will be noticed that the cylinder head *G* was also turned down to fit into the new counterbore.

This arrangement was quite satisfactory until the vessel started out on a certain trip with a first assistant engineer who knew nothing about that bushing. The writer, who was chief engineer at the time, had seen the bushing fitted and knew that the only proper way to pack the cylinder head was at *D* rather than at *F* only.

The vessel had just left New York and had dropped her pilot when the high-pressure cylinder began to wheeze

and whistle, then leak like a sieve through the cylinder head joint, while the engine slowed down considerably. The chief engineer announced to the captain that it would be necessary to drop anchor immediately and the engines shut down. The chief then examined the joint and found that it had been packed at *F* only by the first assistant just before leaving port. Further examination showed that the studs or dowels had broken and allowed the bushing to twist around and partially cover the ports in the cylinder wall. This undoubtedly had more to do with the engine slowing down than anything else. The leaking through the joint was caused by the bushing riding up at *D*, where there was about ⅞-inch clearance.

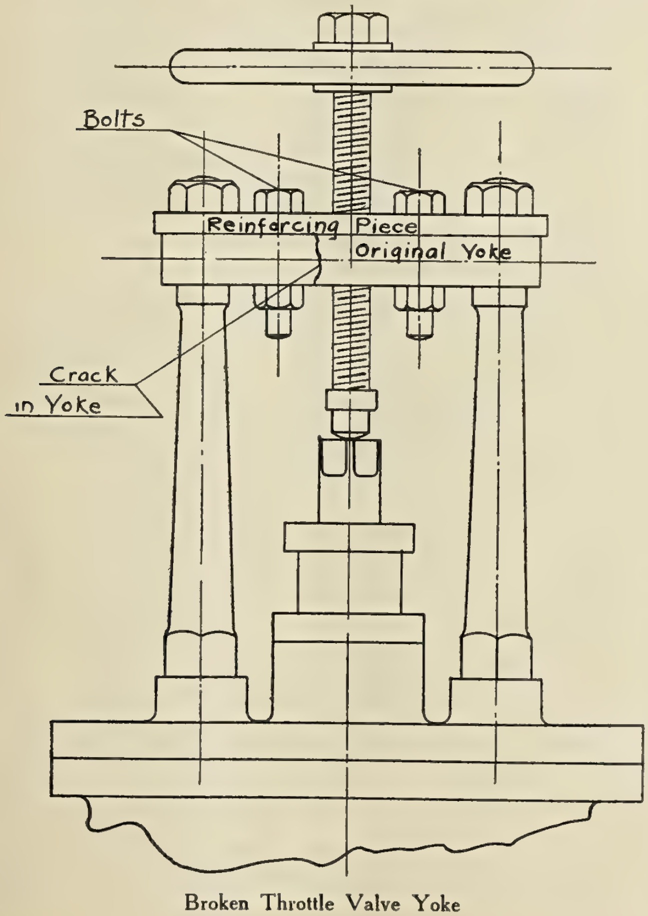
The head was taken off and by using a dolly bar, which had to be bent for the purpose, the bushing was turned back to its original position so that the ports would coincide. It was then rammed down and new holes drilled and tapped in the flange to take the studs *E*. These holes were countersunk and the studs cut off and riveted over to fill the countersink and present a flush surface. The joint was then packed at *D* and the cover replaced and brought down tight. This arrangement worked very well —in fact, it caused no more trouble or anxiety.

If the joint had been packed at *D* as in the usual way there would probably have been no trouble, because when examining the bushing and dowels the writer found that the latter had been broken for some time, and concluded that the packing alone when at *D* had been sufficient to hold the bushing in place. "MAC."

Repairing a Yoke on Throttle Valve

On vessels having no steam traps or drainers attached to the steam pipe water of condensation will cause trouble and usually shows its presence by what is called water hammer. The writer recalls an experience on board a tugboat which had docked overnight with a single crew sleeping aboard. The steam pipe was lower than the water and the drip led to the ash pan. This the fireman closed at night because the steam bothered him, and in the morning he closed the furnace doors before draining the steam pipe. It soon began to hammer and awakened the engineer, who rushed in and closed the stop valve on the boiler. About the time the stop valve was closed the yoke on the throttle valve broke. This had to be repaired immediately, as the boat was to run that day. Fortunately there was about three-quarter inch of thread above the nuts on the standards and a flat piece of iron was found in the junk box sufficiently long to span the yoke and about 3 inches by ⅝ inch, the crosspiece itself being of brass, 3 inches by 2 inches, in section. A hole was drilled in the center of the iron piece a little larger than the stem and two holes about ½ inch in diameter drilled through the iron and brass pieces to match up so that they could be bolted together. Two more holes were then drilled to allow the standards to pass through and the whole placed on them, forming a new yoke. As will be seen, there was just enough thread on the standards to take a full nut. This was a substantial yoke and served as such for about four months, when a new butterfly throttle valve was installed. C.

Albany, N. Y.



Broken Throttle Valve Yoke

Engine Room Bulkheads

Some time ago it was my privilege to be in the engine room of a cargo boat on her trial trip. She was a very fine single screw ship and was supposed to be modern in every detail. Her engines were quadruple expansion and steam was supplied by Scotch boilers with a working pressure of 200 pounds per square inch working under forced draft.

After getting on board we had a general inspection trip. The engines were a very good job and the arrangement of the engine compartment was also good, giving a clean, simple appearance instead of the jumbled thrown-together type of arrangement too often found on cargo vessels. After a thorough inspection of the machinery and after complimentary remarks had been passed to the builders' representative, the engines were turned over and everything prepared for a very successful trial.

In half an hour we were on our way to the measured mile course under natural draft and easy pressure. Upon nearing the buoy, the blowers were started and the boilers fired up. Upon notifying the bridge that all was in readiness, we received orders saying that the trial was on. After running for a while under maximum conditions, we all noticed that the engine room began getting dusty. Ash dust seemed to come from somewhere in large quantities. Of course, dust was very bad for everything and everybody concerned, so an investigation was started. The door between engine room and boiler room was found securely shut, but upon further search it was revealed that the dust was coming through the bulkhead between the engine room and boiler room around the steam pipes. It seems the builders of the vessel had cut large holes in this bulkhead to facilitate the pipe fitting, but had neglected to take any steps to close up the openings after the pipes were in place. In fact, in one case the lead of the pipes had been changed and the old opening in the bulkhead was left untouched, which now formed a good ash dust ejector into the engine compartment.

The conditions soon got so severe in the engine room that it was decided to abandon further trials in order to avoid hot bearings and other damages to the main en-

gines. Ash dust, as is well known to all marine engineers, will get into any bearings and on guide surfaces, and nothing is worse for heating them up, especially on a new job where things are liable to overheat, anyway.

Upon return to the shipyard the engines had to be carefully look over and all bearings everywhere opened up. Since the bulkhead between engine room and boiler room was not a watertight one, it was a simple matter to close up the openings and arrange it dustproof. This was done by bolting circular plates in two pieces to the bulkhead around the pipes and letting the plates bear slightly on the lagged pipes with a piece of canvas between to take care of the irregularities of the lagging and assure a fairly tight job.

All this delay and extra work was caused by carelessness in the first place. The builders should have known the need of a good bulkhead and the owners' representative should have seen that a good one was built. This occurred when all the yards were very busy and behind time in their deliveries, and faults of this kind with their little delays cost both owner and builder a lot of money which could so easily be avoided. STRUCTURE.

Flow of Air Through an Aperture

In the July issue of INTERNATIONAL MARINE ENGINEERING, in an article on "The Rational Non-Diesel Marine Oil Engine," Mr. Albert H. Ziegler makes a statement regarding the flow of air through an aperture which the author cannot very well sustain either practically or theoretically. Mr. Ziegler states: "The velocity of gas through an aperture is dependent upon the ratio of the pressures on both sides of that aperture, whether the pressures involved be high or low."

There follows an example for the purpose of making the matter clear, as follows: "The velocity would be as high through an aperture with a pressure of 2 pounds absolute on one side and a pressure of one pound absolute on the other side as the velocity caused with a pressure of 1,000 pounds absolute on one side and 500 pounds absolute on the other side." Now if this statement were correct, the velocity of a gas through an aperture would vary directly as the pressure; in other words, if we had a pressure of 2 pounds on one side and 1 pound on the other side, our ratio would be two to one, and if we had a pressure of 1,000 pounds on one side and one pound on the other side, our ratio would one thousand to one, and, according to Mr. Ziegler's law, "the velocity varies as the ratio of the pressures," we would in the second case have a velocity 500 times as great as that in the first case.

Now, according to the laws of nature, the velocity of gases passing through an orifice follows the same law as that governing the velocity of falling bodies, disregarding friction, of course, and this law states that the velocity of falling bodies varies as the square root of the height of the fall.

In Mr. Ziegler's example, we have a difference in pressures of one pound in one case and 500 pounds in the other case, both pressures producing the same velocity. Of course, it is understood that with the higher pressures the density of the air is so much greater that its velocity is bound to be impeded, but surely not to such an extent.

The statement regarding the atomizing of the fuel charge is incorrect, as the pressure of the atmosphere due to a partial vacuum in the cylinder is not sufficient for the heavy fuel oils. This I have found to be so in experimenting with the Secor oil engines in which the oil is atomized by "suction." I am using this term with apologies. The Secor engines operate very nicely on kerosene (paraffine) oil, but with the heavier grades of fuel oil there is trouble, as the velocity of the atomizing air is not sufficient to break up the fuel into a spray sufficiently fine to form a perfect mixture. In an earlier paragraph of Mr. Ziegler's article he states that the first and last drops of a full charge always reach the cylinder of the engine in a liquid state, but this is true only with the common atomizers now in use. That it is possible to atomize the full fuel charge I have already demonstrated with an engine of my own design, in which I am using the 5-degree Baume Texas fuel oil with absolutely no formation of carbon deposit in the combustion chamber, and with a colorless exhaust. This engine is a radical departure from the Diesel as well as from the hot ball types of engines, and develops a horsepower on .5 pound of the above-named fuel per hour.

The pressure of the atomizing air in this engine is about 40 pounds per square inch (55 pounds absolute), and this pressure I have found to be the most satisfactory, as the best results are obtained with the least amount of power required for compressing the air. The design of the engine is such that the air is used immediately upon compressing; thus the heat of compression is maintained, preventing the frigerative effect of the expanding air upon the oil.

The tendency among oil engine designers is to use as little air as possible for atomizing the fuel. In the Diesel engine it would be out of the question to use a large volume of air for this purpose, as with such high pressures the power consumed by the compressor would be too large a factor, but with a pressure of only 40 pounds we can afford to be more liberal with our air supply as long as we can offset the extra power required for compression by greater fuel efficiency. H. E. A. RAABE.

Jersey City, N. J.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		May 1.	Aug. 1.
Nevada	28,000	20½	Fore River Shipbuilding Co..	63.9	72.4
Oklahoma ...	28,000	20½	New York Shipbuilding Co..	67.2	72.6
Pennsylvania.	31,400	21	Newport News Shipbuilding..	29.1	42.0
Arizona	31,400	21	Navy Yard, New York......	11.5	24.4

TORPEDO BOAT DESTROYERS

Downes	1,010	29	New York Shipbuilding Co..	95.3	95.3
O'Brien	1,050	29	Wm. Cramp & Sons.........	62.2	79.0
Nicholson ..	1,050	29	Wm. Cramp & Sons.........	60.5	73.3
Winslow	1,050	29	Wm. Cramp & Sons.........	54.4	71.5
McDougal ..	1,050	29	Bath Iron Works............	89.3	100.0
Cushing	1,050	29	Fore River Shipbuilding Co..	41.5	56.1
Ericsson	1,050	29	New York Shipbuilding Co..	61.6	76.9
Tucker	1,090	29½	Fore River Shipbuilding Co..	9.4	12.6
Conyngham..	1,090	29½	Wm. Cramp & Sons.........	6.8	11.1
Porter	1,090	29½	Wm. Cramp & Sons.........	6.7	9.0
Wadsworth..	1,090	29½	Bath Iron Works............	17.5	48.4
Jacob Jones..	1,090	29½	New York Shipbuilding Co..	9.8	14.9
Wainwright..	1,090	29½	New York Shipbuilding Co..	9.8	14.4

SUBMARINE TORPEDO BOATS

G-4	....	....	Wm. Cramp & Sons.........	96.4	96.4
G-2	....	....	Newport News Shipb'g Co...	89.7	89.7
G-3	....	....	Lake T. B. Co..............	81.6	82.3
K-3	....	....	Union Iron Works..........	94.0	98.1
K-4	....	....	Seattle Con. & D. D. Co.....	93.9	98.8
K-5	....	....	Fore River Shipbuilding Co..	92.8	98.8
K-6	....	....	Fore River Shipbuilding Co..	92.8	98.8
K-7	....	....	Union Iron Works..........	88.9	94.3
K-8	....	....	Union Iron Works..........	88.4	94.3
L-1	....	....	Fore River Shipbuilding Co..	30.3	49.3
L-2	....	....	Fore River Shipbuilding Co..	30.3	48.2
L-3	....	....	Fore River Shipbuilding Co..	30.3	47.3
L-4	....	....	Fore River Shipbuilding Co..	30.2	46.6
L-5	....	....	Lake T. B. Co..............	8.1	28.9
L-6	....	....	Lake T. B. Co. (Long Beach, Cal.)	0.0	28.1
L-7	....	....	Lake T. B. Co. (Long Beach, Cal.)	0.0	26.6
M-1	....	....	Fore River Shipbuilding Co..	20.8	33.1
L-8	....	....	Navy Yard, P'tsmouth, N. H.	0.0	0.0
L-9	....	....	Fore River Shipbuilding Co..	1.9	12.3
L-10	....	....	Fore River Shipbuilding Co..	1.9	12.3

Marine Articles in the Engineering Press

Discussion of Feed-Water Heating, Oil Burning and Economy of Steam Power Plants—New Methods of Propulsion—Harbor and Canal Improvements

Marine Feed-Water Heating.—By Lieutenant Commander H. C. Dinger, U. S. N. In presenting the general methods of reducing steam consumption in marine engineering, and particularly the use of feed-water heating as applied for that purpose, the author of this article shows a clear conception not only of the theoretical side of the question, but of the practical one also. Economy finally resolves itself into the question of conserving the heat units, making it a thermodynamic problem so that success can only be obtained by properly following out thermodynamic principles. The questions of vacuum, superheat, and feed-water heating are almost utterly neglected in marine practice, and the author explains that it is probably due to the first cost being considered too much. Important note is made of the fact that different designs of engines vary the economy, but the possibilities to be gained by the use of superheat, high vacuum and the highest feed temperatures are greater than changes in design are likely to produce for several years to come. The subject of feed heating is discussed in detail and includes the general principles underlying the subject for naval and marine work and deals largely with the practical points of the construction, etc., of the various types of feed heaters. Two tables are included for practical use, one giving the percentage of saving in fuel by heating the feed water with exhaust steam assuming 100 pounds boiler pressure, the other giving the percentage of saving for each degree of increase in temperature of feed water heated by waste steam. In connection with these tables general data are presented in such a clear, concise manner that it is convincing enough to eliminate all argument against using a system for feed heating. The general types of feed heaters are described and discussed with regard to relative merits and advantages under different conditions for adaptability. To carry out the practical description, together with constructive details, such subjects as piping of heaters, steam piping connections, position of steam and water connections, baffling, kind of tubes and fittings are discussed. Practical information is given for the heating surface required, including data for the same on such types as Normand or Wainwright plain-tube heaters, Reilly heaters, Wainwright corrugated tube heaters and Schutte and Koerting film heaters. A discussion of the sizes of tubes used in heaters shows how these may effect efficiency, weight and cost. Descriptions of the flow of steam and water through heaters, operation of heaters, saving due to heaters, installation, series heaters, special types of heaters and the effect of condenser arrangements and operation on feed heating are given in such detail as to make the information extremely valuable, especially in deciding which type would be applicable under the various conditions of operation. The comments made upon the design, construction and operation of the various types are based on the results of actual experience in operation, therefore the information is quite unbiased and reliable. 17 illustrations. 14,000 words.—*Journal of the American Society of Naval Engineers,* February.

Oil Burning.—By Lieutenant Commander John J. Hyland, U. S. N. The subject of fuel oils, their composition, general characteristics, and their utilization in oil-burning boilers, with a description of the apparatus employed and the means used to properly burn them, is treated very thoroughly in this article, and the author has included extensive data, mostly in the form of statistics regarding the yield and various characteristics of the oils. Fuel oil is classed as topped crude oil or petroleum—i. e., crude oil with its lighter, more valuable and dangerous constituents removed by distillation. Petroleum or crude oil is divided into three classes, and according to Dr. David T. Day, of the U. S. Geological Survey, these may be traced to one complex mother oil of the asphaltic type. Dr. Day further states that the yield of the United States in crude petroleum is 220,000,000 barrels, and gives a table showing their division by distillation or fractionation. Following this are tables showing the world's production of petroleum in barrels for the years 1907 to 1911, inclusive, the various chemical constituents and characteristics of the various fuel oils. Before an oil is burned certain tests should be made to determine its characteristics. These tests are enumerated and the author has described each one in detail, giving methods and formulæ where needed. It was found that in order to have an explosive mixture 1 percent to 1.5 percent of vapor is needed, and a table is given, including data obtained with different kinds of oil, showing temperature to which oil was heated, oxygen percent, vapor percent and flash points. Turning to the subject of burning fuel oil in a boiler under mechanical or pressure systems of atomization, it is conveniently divided into three heads: the boiler furnace and its accessories; the oil-burning apparatus proper, consisting of burners, tuyeres, air cones or air registers; and air regulation, oil regulation and aids used to make the combustion as perfect as possible. Under these three heads the mechanical system of burning oil, the various apparatus used since its development, and the changes made therein since the mechanical system was introduced, are described in detail and the methods of burning oil with steam or air burners are described briefly. The proper stack or uptake area is discussed in connection with a table showing results obtained with a Yarrow boiler having a steam pressure of 240 pounds and 4,500 square feet of heating surface. Fire brick also forms an important part of the system in its function as a refractory lining for the furnace. The discussion of burners, the principles employed in their manufacture, and the various types used correct the idea of oil issuing from the burner tip of a mechanical form in a revolving spray and presents the reader with the fact that the oil issues in straight lines in a hollow conical spray of various angles up to 90 degrees. The various types of burners are described, such as the Schutte-Koerting, Thornycroft, Howden, Bureau Steam Engineering, Normand, Fore River and Peabody burners. Several curves are also given showing pounds of oil discharged per hour per burner plotted on the discharge pressure at burners in pounds gage. Another set of curves shows viscosities Engler compared with water at 70 degrees Fahrenheit equals unity plotted against temperature in degrees Fahrenheit. A set of curves for pumping capacities of Mexican oils shows the delivery in gallons per hour plotted on temperature in degrees Fahrenheit. There is also included a curve of very interesting character showing the temperature capacity of a Peabody mechanical burner. This

curve gives the pounds of oil per hour per burner plotted against the temperature of oil in degrees Fahrenheit. The subject of air cones, air registers or tuyeres is then discussed and the various types described. The amount of air required for combustion forms a computation study and necessary formulæ are developed. Air chambers on fuel oil lines, aids to combustion and methods of running under an oil-fired boiler (including curves of data obtained under such conditions with Yarrow, Normand and Babcock & Wilcox boilers) conclude the article through mechanical burners. The subject of steam or air burners is divided into two general headings, their general classification and the various types used for both metallurgical work and boiler work. There are five general classes, besides the two main divisions of outside and inside mixing. These are drooling, atomizer, chamber, injector and projector burners. The various types described are the Peabody burner, W. N. Best high-pressure oil burner, Gem oil burner, Gilbert & Parker oil burner, Rockwell high-pressure, Hammel, Kirkwood, Lassoe, Ingram and Fitton oil burners. Two safety devices for oil are described, the Lalor valve and the Foster valve, both of which have the same essential principle. The author concludes with a general statement, pointing out that it is no easier to burn oil with the use of compressed air or steam than with the mechanical system. 56 illustrations. 10,200 words.—*Journal of the American Society of Naval Engineers*, May.

New Ship Propelling Methods.—An important feature of modern marine steam engineering is stated to be the installation of exhaust turbines in connection with reciprocating engines. The advantages of this arrangement, usually of one turbine to two reciprocating engines, are found to be on the average a full power steam economy of 25 percent over installations entirely of reciprocating engines and a saving of space over installations entirely of turbines. Data are given of the plants of the German steamer *Cap Trafalgar* and the British steamer *Britannic.* Modern Diesel engine plants are considered to be a little under a cloud at present, due to rather too highly pitched expectations of economy. Shipowners are disappointed partly on account of delayed deliveries, of unexpected breakdowns, partly on account of a rise in the price of fuel oil, of unexpectedly high consumption of lubricating oil and of a higher wage scale for engine room crews. All this in connection with high first cost and interest charges has dampened the enthusiasm for Diesel engine installations. A number of recent plants are described like the ones in the French sail ship *La France,* in the Italian three-mast schooner *Aosta,* in the German tanker *Wotan* and in the Danish freighter *Fionia.* While the first three installations have two-cycle engines, the last one has four-cycle engines, and the builders are said to have consistently stuck to this type. Of the *Wotan* installation a number of the difficulties experienced on the first voyage are given as observed and reported by an engineer of the builders. 22 illustrations. 3,370 words.—*Zeitschrift des Vereines Deutscher Ingenieure*, May 2.

Economical Performance of Various Recent Naval Vessels.—The data tabulated in this article were taken from trial performances of eight destroyers and two battleships and show the water and fuel consumption on different trials. All vessels included, except the *Henley,* were fitted with Parsons turbines. The *Henley* has Curtis turbines. It is noted that the water evaporated per pound of oil at full power, which averages about 12.5 pounds, is hardly a very creditable performance, but that on more recent destroyers these results have been considerably bettered. It is also noted that the boilers and oil-burning apparatus installed are capable of giving an evaporation of 14 pounds of water per pound of oil at full power when operated to the best advantage. For the destroyers the table of data includes total pounds of water per hour for all machinery, pounds of water for all machinery per hour per shaft horsepower of main engines, pounds of water evaporated per pound of oil (actual), pounds of oil per hour total per shaft horsepower of main engines, square feet of heating surface per shaft horsepower of main engines, knots per ton of oil, speed of vessel and slip of propellers in percent. The same relative data are tabulated for two battleships using coal instead of oil as in destroyers. The large steaming radius of the destroyers has been obtained by the adoption of cruising engines or cruising turbines. To approximate to the amount of water used for auxiliaries measurements were taken of all the water on one destroyer and only that used by the main engines on two others. These results, which show that the auxiliaries use from 13 percent of the total water at full speed to 26 percent at 12 knots, show that at all speeds more auxiliary exhaust is available than can be utilized in the feed-water heater. There is a close agreement of water consumption on the battleships with that on the destroyers, but the propeller efficiencies on the former are considerably better, making a materially better overall efficiency. Considering the engine and boiler-room weights only, the battleship weights will run 21 to 23 horsepower per ton, while the machinery weights on destroyers are about one-half per horsepower of what they are on battleships. 1,630 words.—*Journal of the American Society of Naval Engineers,* May.

Transmission of the Propulsive Power in Ships.—By Ernest N. Jason. A brief outline shows the three general successive steps in the transformation of the potential heat energy of the fuel into the mechanical energy in the form of rotary motion of the propeller as applied to the propulsion of ships. The first, that of transforming the potential heat energy of coal or oil into effective heat energy of water, steam or a fluid of gas mixture, is accomplished by such apparatus as boiler, producer or apparatus for the combustion of the fuel and the formation of a fluid possessed of the necessary energy. The second, that of transforming the effective heat energy into mechanical work and rotary motion, is accomplished in the steam engine, steam turbine or internal combustion engine, together with all necessary auxiliaries. The third, that of transmitting the motion of the prime mover to the propeller, is the question that forms a basis for the author's discussion. This transmission from the prime mover to the propeller is accomplished by direct coupling or by some system of indirect transmission, such as mechanical gearing, electrical transmission and hydraulic transformers. An illustration serves to show the importance in the question of transmission. The coal consumption of the U. S. S. *Delaware* is assumed brought down to that of the U. S. S. *Texas* for the same conditions, and using this as a basis figures are given to compare resultant and actual coal consumption for a day and for different cruising radii. Similarly a great saving is shown for a vessel of 72,000 horsepower in which the coal consumption is assumed cut from 1.45 to 1.3 pounds per horsepower, illustrating the need for "unrest" and the numerous designs for the best solution of the problem of transmission. A table giving the names and approximate horsepower of types and combinations of propelling machinery, as extensively used in nearly all classes of ships, both of commercial and naval

importance, gives a clear idea of the extent to which the various combinations for transmission have been applied in practice. The various combinations are again enumerated and their applications discussed, followed by a classification of the three general systems with their advantages and disadvantages. In order to have a clear idea of these as applied, the author describes the various systems in detail, giving necessary requirements, especially in that of mechanical gearing. The author has also included for comparison a table giving names of ships, year tried, system of power transmission, prime mover, maximum speed in knots, revolutions of propeller per minute, speed reduction ratio, total shaft horsepower and water consumption in pounds per shaft horsepower, together with remarks. Another table includes similar data, together with vacuum in inches of mercury, pounds of coal or oil per hour per horsepower, British thermal units per pound of coal or oil, thermal efficiency in percent of main engines, and British thermal units per minute used by whole machine installation per pound of indicated thrust. This table forms a resumé of the examples, which follow it, and serves to illustrate the economic value of several types of the most modern marine installations. 8,300 words.—*Journal of the American Society of Naval Engineers,* February.

The Development of Bremen in the Line of Harbor and River Construction Since 1880.—It is stated that to maintain the possibility of direct oversea traffic for the city of Bremen an extensive correction and dredging of the river Weser was required. Since 1884 this has been proceeded with after a systematic and carefully executed layout which established such depth of water that ships with 16 feet 5 inches draft could come up to the city of Bremen. It is shown that in the stream correction careful account had to be taken of the influence of the tide, amoúnting at Bremerhaven to about 12 feet, and of the volume of fresh water from the upper river, which led to the plan of contracting the river bed into a uniformly determined profile wherever it had been split or flattened out, or removing obstructions or excessive curvatures wherever they hindered the free flow of the water. To remove the amount of nearly 55,000,000 cubic yards that required dredging, the city of Bremen acquired three dredges and a large number of scows to the total value of over $1,500,000, which in 1895 completed the stream regulations. Since then, upon the establishment of 16 feet 5 inches draft limit, the adjoining villages and the city of Bremen have extended their docks and landings to a remarkable degree. For the future a deepening to 21 feet draft limit has been decided upon which it is expected will greatly enlarge the direct sea-borne traffic of the city. 5 plates. 61 illustrations. 8,000 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* June 6.

Intracoastal Waterways—The Cape Cod Canal.—By Lieutenant Commander A. St. Clair Smith, U. S. N. Introducing the subject of "intracoastal waterways" as referring to various plans, schemes and suggestions to connect certain of our coastwise cities by inland canals for the transportation of freight principally, the author of this article points out that the time is closely upon us when water transportation will inevitably come here as it has in Europe. A brief outline of the advantages gained in such cases as the utilization of the Great Lakes as an avenue of commerce, and the Sault Ste. Marie Canal, together with a few statistics from the census report of 1904 concerning the industries in the Atlantic States, is more than convincing enough to show the soundness of the business judgment that has resulted in the construction of the Cape Cod Canal. This canal, it is pointed out, was the most serious attempt in many years at a commercial canal in this country, and the locality has always seemingly offered the greatest advantages for the least effort. As early as 1697 the General Court of Massachusetts appointed a committee to survey a route across the neck of land separating Cape Cod and Buzzard's Bay. From that time until the present day the matter has been under consideration either by the government, shipowners or by capitalists. The distance is but eight miles and the surface is low. Although various attempts have been made and no serious engineering difficulties met with, the enterprise was never completed until the present company formed in 1907, and, headed by Mr. August Belmont, began operations. A stone jetty 3,000 feet long has been built to protect the northern entrance of the canal, which is 30 miles in a southerly direction from Boston. The canal prism is a cut which is at first to have a depth of 25 feet, with a bottom width of 100 feet in the narrowest parts. The northern approach has a bottom width of from 200 to 300 feet for a distance of 7,000 feet and the southern approach has a bottom width of 200 feet for a considerable distance. There are two points of passage in the canal itself where the width is 250 feet. The saving for vessels ordinarily taking the outside route—i. e., through Vineyard Sound but around Cape Cod to Boston—from all southern ports is about 60 nautical miles, while for those going around the Nantucket South Shoal Lightship it is 144 miles. The author, however, by a brief description shows clearly that there will be a much greater saving due to the curious differences in the weather conditions of the two localities. In concluding the article the author presents some astonishing figures comparing the carrying capacity of canals and railroads in general from a commercial standpoint, in which canals are many times greater than the railroads. By a similar comparison these advantages are shown to be even greater from a military standpoint in times of war, not only for transportation purposes, but, as is well known by naval men, such a canal up and down our east coast is a military asset of great and undisputed value. 1 illustration. 3,700 words.—*United States Naval Institute Proceedings,* May-June.

Operation and Trials of the U. S. Fleet Collier Jupiter.—By Lieutenant S. M. Robinson, U. S. N. A previous description of the *Jupiter* included the methods of operation at the time the dock trials were held. Since then extensive trials have been held and these methods somewhat modified, shortening the time of reversing. For that reason the author of this article describes the method of operation, and, briefly, the system of interlocks on the switches. The change on the switches is briefly described, followed by an outline of the three general methods of operation under different conditions. To explain clearly the object of the resistances, as used, a set of curves illustrates the torque on speed for the *Jupiter's* motors with resistance in and out. It is seen from these curves that the torque of the low resistance condition is very low for both backing and starting, while for the high resistance condition the torque is nearly maximum for both starting and backing. A description of the method of getting under way on the *Jupiter* shows that the method is very similar to that of other ships. The maneuvering qualities of the electric drive, it is claimed, have proved highly satisfactory, and the advantages claimed for it certainly overbalance the disadvantages. Standardization trials of the *Jupiter* held at Santa Barbara are completely summarized, with resultant curves showing revolutions, shaft horsepower and percent slip plotted on knots. Pre-

vious to the trial, which included seventeen runs, a 48-hour high-speed trial was run on the way to Santa Barbara. The data for this trial and the 24-hour run, started immediately after standardization, are included in a table of trial data. On the 48-hour high-speed run the average speed maintained was 14.99 knots, the water rate 11.68, which is 10.15 percent better than the guarantee, and the coal consumption per day at this speed 127.39 tons. On the 24-hour endurance run at 10 knots the water rate was 12.32 pounds per shaft horsepower, which is 18 percent better than the guarantee, and the coal consumption per day 54.08 tons. Before summing up the case of the electric drive the author gives data in the form of curves obtained at the factory in Schenectady, showing water rates for 6 and 9 stage turbines plotted on kilowatts, and also curves obtained in the factory for the motors. In summing up the author concludes that the electric drive seems well adapted to ships of 5,000 horsepower and above. Undoubtedly the ideal place for it is on a battleship, and in this connection about a dozen important advantages are given which tend to verify the conclusion. 5 illustrations. 4,700 words.—*Journal of the American Society of Naval Engineers,* May.

The Sidewheel Tugboat France.—The article gives an account of the effort of a French company at Lyon to improve the shipping traffic between Lyon and the Mediterranean, for which were constructed three sidewheel tugs, two propeller tugs and thirty-six tow boats. The three sidewheel tugs were constructed by Escher, Wyss & Co., of Zurich, Switzerland, to fulfill the difficult task of going over the rapids without subdivision of the tow. The *France* is the first of these, of the dimensions 236.2 feet by 28.2 feet by 10.2 feet by 3.45 feet draft, with a diagonally inclined compound engine 30¾ inches by 53½ inches by 70⅞ inches stroke, driving two paddle wheels 14 feet 10 inches diameter by 8 feet 2½ inches wide each. The two fire rooms contain four Scotch boilers each with two corrugated furnaces and 1,400 square feet heating surface and a superheater of 269 square feet of the large flue type. The condensing plant of the jet type and the pumps and other auxiliaries are described, as well as one of the steel tow barges 255.9 feet by 25.9 feet by 8.2 feet by 5.9 feet draft, carrying 615 tons cargo. The trial trips are stated to have shown about 1,170 indicated horsepower at 38 revolutions per minute, with 173 pounds pressure on the boilers, a superheated steam temperature of 505 degrees F. and a vacuum of 24 inches. Under these conditions the coal consumption is given as 1.61 pounds per indicated horsepower per hour. In actual service the whole trip of about 170 miles was made in 48 hours, exceeding the requirements by about 25 percent. 14 illustrations. 1,850 words.—*Schiffbau,* July 22.

School Motor Sailship Great Duke Friedrich August.—Mention is made of the activity of the German schoolship society to train able seamen in sailships, of which this ship is the third. Built by the firm of Joh. C. Tecklenborg Company, in Bremerhaven, she is rigged as a bark and fitted with a 600 horsepower two-cycle crude oil engine of the Carels type. With dimensions 249.4 feet by 41.6 feet by 24 feet by 17 feet draft, she displaces 2,350 tons and measures 1,700 gross tons. The hull is built of steel to the highest class of the Germanic Lloyd fitted with six transverse watertight bulkheads, and has two continous decks, a long poop, forecastle and deckhouse with accommodations for 14 officers and passengers, about 200 apprentices, 20 petty officers and stewards and about 40 seamen. Aside from the propelling engine, a donkey boiler of 215.2 square feet heating surface for 100 pounds pressure is provided for steam pumps, winches and heating. Stowage is provided for 60 tons coal, 22 tons fresh water and 100 tons fuel oil. The boat equipment consists of ten boats, one with motor, and one punt. To carry her rig of about 21,500 square feet of sail more effectively 500 tons of ballast have been stowed below. The main masts and spars are of steel with galvanized steel standing and steel wire and manila running rigging. The propelling motor of the four-cylinder, two-cycle, single-acting crude oil type resembles a marine steam engine in the bed plate, columns, shafting, etc. The engine is simple, with scavenging slots in the cylinder walls opposite of the exhaust slots. Pistons and cylinders are cooled with sea water. The oil auxiliaries are one 30-horsepower compressor and one 12-horsepower dynamo. The total weight of the 600 horsepower engine plant is given as 115 tons. 6 plates. 5 illustrations. 4,500 words.—*Schiffbau,* July 8.

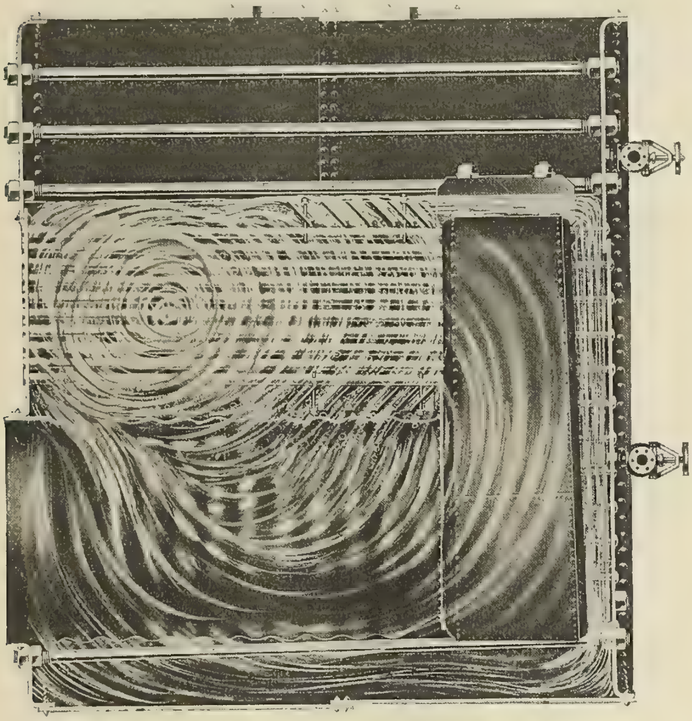
The Injector Air Pump of Westinghouse Leblanc.—After pointing out the great importance and influence of condensation upon the economy of turbine plants, mention is made of the modern tendency to replace piston air pumps by rotating injector principle air pumps of the dry air type. After discussing the characteristics of fully and partially charged rotating pumps, it is said that for large air volumes an additional jet of steam is often employed in the manner of the Parsons augmenter. A considerable improvement over this is stated to be the newly designed injector air pump of Leblanc. The characteristic features of this new form are: a subdivision of the working jet into two stages each of a number of small units in different heights to facilitate the mixture of the air with the escaping steam, and an automatic air cushion of annular form which regulates the area of the mouth of the diffuser nozzle to the requirements of starting or running conditions. It is stated that in an electric power station in Paris one of the jet air pumps was tested against a rotary pump, each producing a vacuum of nearly 29 inches with a steam consumption of about one percent of the full power consumption of the turbine. Another test on the French torpedo destroyer *Bontefeu* showed at low powers an economy of oil consumption of about 16½ percent. The principal advantages are given as: No moving parts, high efficiency, small space required, and no repairs. 12 illustrations. 3,050 words.—*Schiffbau,* July 8.

Ships with Diesel Engines of the Mercantile and Naval Service. II.—This article is concluding tabular records with notes on Diesel engine ships up to July, 1914. Table II deals with oil tankers, of which 48 are more or less completely detailed in regard to size of hulls, displacement, register tonnage, cargo capacity, speed, builders, type and size of engine, as well as power. A number of the important ships have special notes on trial trips, oil consumption, steam or oil auxiliaries, engine weights and reduction of crew over steam requirements. Table III deals in similar manner with 27 tugboats and Table IV with 33 sail ships, fishing vessels and other ships of miscellaneous classification. Table V is devoted to 55 vessels of the naval service of various governments, including submarines, torpedo boats, gunboats and launches. Table VI is given to 72 engines for miscellaneous vessels not mentioned in the five previous tables. Finally, such additional notes are given of vessels in Table I as became known on more recent dates of trial trips, auxiliaries, mishaps, fuel consumption, decrease of crew, cargo capacities on actual runs. 5 tables. 6,150 words.—*Schiffbau,* July 8.

ENGINEERING SPECIALTIES

The McNab Cascade Boiler Circulator and Fuel Economizer

The most serious drawback to a Scotch boiler is the lack of perfect circulation. On account of this, deadwater is usually found below the fire grates and, what is still more important, certain surfaces exposed to the flame or gases inside the boiler, which ordinarily should be counted as heating surface, prove ineffective as a heating surface. An example of this is the combustion chamber



tube plate, which is installed in a vertical position in order to accommodate the tubes, and is exposed to the full force of the flame and gases within the combustion chamber. Without positive circulation around the tube plate the steam containing bubbles generated on the furnace crowns ascends rapidly in a direct vertical line toward the steam space, and these bubbles, rising vertically in front of the tube plate, insulate the plate and prevent its coming in direct contact with the water. This insulation is considered by many to be the direct cause of the tube plate becoming overheated, of the heavy scale and blister formation usually found adhering to its surface, and of the general deterioration of the tubes adjoining the plate.

To overcome this drawback, the McNab Company, Bridgeport, Conn., has placed on the market the "Cascade" boiler circulator and fuel economizer, illustrated on this page. This device consists of a series of diaphragm deflecting vanes inclined at an angle of 45 degrees towards the tube plate, installed above each furnace and extending 36 inches from the combustion-chamber front. The rapid current caused by the rise of steam containing bubbles generated on the furnace crowns comes in direct contact with the inclined diaphragm vanes, which deflect the current at an incline toward the tube plate, and also force a much heavier body of water to flow through the hottest parts of the tubes near the tube plate. The water impinged at an angle against the tube plate, it is claimed, washes off the bubbles and prevents insulation, converting this plate into an efficient heating surface.

The circulation throughout the boiler is caused by the diaphragm generating vanes installed on the top row of tubes. The rapidity of the upper current is greatly accentuated by the additional heat imparted to the water through coming in contact with the hot tube plate, and this current is deflected above the tubes in such a manner as to create a longitudinal circulation. While the circulation at the bottom of the boiler is positive, it is not of sufficient force to drive the heavier foreign substances, such as mud, sediment, etc., toward the surface.

The McNab "Cascade" circulator is easily installed without cutting or mutilating the boiler in any way. The largest parts of the circulator will readily pass through an ordinary manhole, and the vanes are held in place by ⅝-inch hook bolts attached to the outer tubes. By loosening the hook-bolts they can be readily shifted to the front end of the boiler to permit cleaning or internal inspection.

Electrically Lighted Launches and Tug Boats

A simple, reliable and efficient method of lighting steam launches by electricity has been developed by the Westinghouse Machine Company, East Pittsburg, Pa., which has placed on the market for this purpose a small, compact turbo-generator of 1 kilowatt capacity. At a speed

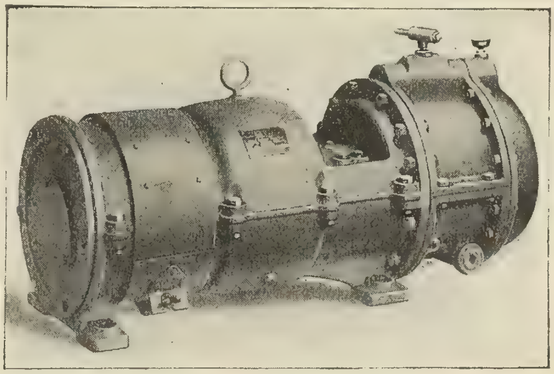


Fig. 1.—Westinghouse 1 Kilowatt Turbo Generator

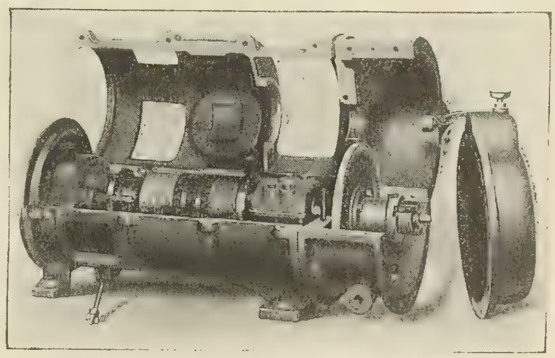


Fig. 2.—Turbo Generator With Casing Raised

of 4,000 revolutions per minute this outfit develops sufficient current at 120 volts to supply forty 25-watt lamps. It weighs only 400 pounds, is 35 inches long, 17 inches high and 14 inches wide. At full load it uses about 160 pounds of steam per hour.

In the design of this set reliability was the first consideration. The turbine and armature are mounted on a single shaft with a governor at the end of the shaft controlling the amount of steam admitted to the turbine.

There are no delicate adjustments to be made. Every part is easily accessible for inspection, and the machine can be installed by the ship's force and operated with very little attention. Large bearings, lined with the best grade of babbitt, are automatically lubricated by oil rings from reservoirs which require refilling only once in several months. The governor, it is claimed, keeps the speed uniform for all ordinary variations of load and steam pressure. At 90 pounds steam pressure the turbine will develop full rating, although it is suitable for pressures up to 250 pounds per square inch.

Six of these units have recently been installed for lighting the steam launches of the Argentine battleships *Moreno* and *Rivadavia.*

An Achievement in Marine Refrigeration

On July 6 the United States Government awarded a contract to the Shipley Construction & Supply Company, Brooklyn, N. Y., agents for the York Manufacturing Company, York, Pa., to install on the United States transport *McClellan,* at Erie Basin, Brooklyn, a 35-ton York steam-driven refrigeration machine. The contract called for completion of the work (under forfeit) in ten days, and included, besides the installation of new work, changes to system already in operation. As a matter of fact, steam was given to the machine and brine lowered from 35 degrees F. to — 4 degrees F. in less than nine days.

Besides installing the equipment mentioned above, the contractors disconnected the brine coolers already in operation, changed their position to make room for the new machine, and connected up the complete plant to work interchangeably with a machine already installed. This installation was made to serve a number of compartments in which will be carried, with other perishable foodstuffs, frozen beef to troops at tropical stations.

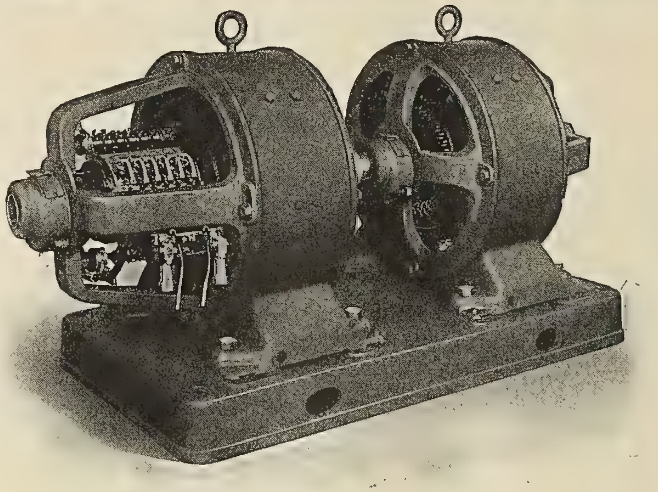
The equipment installed consists of a 35-ton horizontal double-acting ammonia compressor, driven by a 13½-inch by 24-inch horizontal engine. The compressor is of the newest "hog back" type, in which the water jacket, ammonia cylinder and crosshead barrel are connected by a single casting instead of by tie-rods. The condensers are of the "Shipley" flooded type, which it is claimed are more efficient and at the same time occupy less space than the regular style of ammonia condenser. The whole outfit, exclusive of pipe connections, weighs in the neighborhood of 18 tons.

All the piping used was cut and tested under water at 300 pounds pressure at the shop of the Shipley Construction & Supply Company, before going aboard the *McClellan.* Only genuine wrought iron pipe was used, and litharge and glycerine flanged joints were made on all ammonia connections.

Westinghouse Arc Welding Apparatus

Realizing from past experience the practical value of the electric arc for general welding purposes, the Westinghouse Electric & Manufacturing Company, East Pittsburg, Pa., has developed a standard line of electric arc welding equipments. The equipments comprise standard apparatus. They are simple in construction and easy to operate. Complicated relay schemes for automatically inserting resistances are eliminated. Ample protection is secured, it is claimed, by circuit breakers and special arrangement of the resistance. The outfits are furnished complete in the four following sizes: 200, 300, 500 and 800 amperes.

Each equipment includes a welding generator, or a welding motor-generator set, switchboard, control and all necessary accessories. The welding generator consists of a special 75-volt, commutating-pole, direct-current machane, either belt or motor-driven. The instrument and control panels are composed of two sections. The upper section contains the indicating instruments, protective apparatus and switches arranged for regulating the welding current, and the lower section contains the starting and protective equipment for the motor-generator set. It is often desired to have several welding circuits connected



Welding Motor-Generator Set

to one generator. For this arrangement a control panel is provided for each circuit. Each panel can be located at the most desirable place. Metal or carbon pencil welding can be done from any of these panels independent of all others, and one or more arcs can be operated simultaneously.

The accessories furnished consist of a carbon holder and a hood for protecting the operator, together with a shield and a metal holder for each welding circuit.

Lloyd's Wreck Statistics for 1913

The statistical summary of vessels totally lost, broken up, condemned, etc., now published by Lloyd's Register, shows that, during 1913, the gross reduction in the effective mercantile marine of the world amounted to 665 vessels of 717,030 tons, excluding all vessels of less than 100 tons. Of this total, 371 vessels of 533,002 tons were steamers, and 294 of 184,028 tons were sailing vessels.

These figures, as regards steamers, are lower than those for 1912 by 39,743 tons; but as regards sailing vessels, they are for the year 1913 somewhat higher, viz., by 7,808 tons.

One of the most common terminations of a vessel's career is by breaking up, dismantling, etc. (not in consequence of casualty). The amount of tonnage so dealt with in 1913 was 108,795 tons, this being 48,846 tons less than that for 1912. Nearly 20½ percent of the steamers and 16 percent of the sailing vessels removed from the merchant fleets of the world in the course of 1913 are accounted for in this manner. Of the total tonnage of such cases 42¾ percent is represented by United Kingdom vessels.

Strandings and kindred casualties which are comprised under the term "wrecked," are much the most prolific cause of disaster. To such casualities are attributable over 58½ percent of the losses of steamers, and over 54 percent of sailing vessels. Cases of abandoned, foundered, and missing vessels are no doubt frequently more or less similar in the circumstance of loss. If these be taken collectively, they form about 21¾ percent of the steamers, and over 29 percent of the sailing vessels removed from the mercantile marine during 1913, owing to casualty.

Personal

John Maloy, of Rensselaer, N. Y., is chief engineer of the towing steamer *Victoria,* of New York harbor.

Paul Revers Smith, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Aaron Matheis, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Chester Arthur Beckley, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

Isaac John van Kammer, cadet engineer in the United States Revenue Cutter Service, has been appointed third lieutenant engineer.

John P. Bean, formerly with the Mississippi Dredge Fleet, has been appointed chief engineer of the new Arkansas River dredge *H. S. Tabor.*

James Bullock, first assistant engineer of the *Mongolia,* will act as chief engineer of the vessel, relieving the chief engineer, Robert Paul, temporarily.

Arthur Phillips, formerly with the Mississippi Dredge Fleet, has been apointed first assistant engineer on the Arkansas River dredge, *H. S. Tabor.*

Leonard Alling, engineer for the New England Steamship Company, has accepted a position as engineer on the steamer *Rowe,* of New Haven, Conn.

William Fairbrother, formerly chief engineer of the *Greenport,* has been transferred to the *Frank Jones,* of the Hudson Navigation Company, New York.

Michael Dugan has been appointed chief engineer of the steamer *Angler,* which is in service on the Potomac River, to take the place of Merril Marden, resigned.

Benjamin Free, chief engineer of the *City of Sidney,* of the Pacific Mail Steamship Company, San Francisco, Cal., has been appointed assistant to William Chisholm, superintendent.

Frank Smith, engineer of the *John Seeley,* of the Seaboard Equipment Company, New York, has been appointed engineer on the steamer *William M. Merwin,* of Milford, Conn.

John Barratt, formerly first assistant engineer on the *Nile,* of the Pacific Mail Steamship Company, San Francisco, Cal., has been appointed chief engineer of the *Peru,* of the same company.

William Lovell, formerly first assistant engineer of the *Bear,* has been appointed superintendent engineer of the San Francisco & Portland Steamship Company, with headquarters at Portland, Ore.

E. K. Morgan has been promoted from the position of foreman to superintendent of the Rockford Drilling Machine Company, Rockford, Ill. Mr. Morgan succeeds John S. Langwill, lately deceased.

Henry Hunt is chief engineer of the night crew on the tow-boat *George N. Southwick,* of the Great Lakes Dredging & Towing Company. Captain Melvin van Steenburg is in command of the boat.

W. L. Martignoni has been appointed chief engineer of the *George W. Elder,* of the North Pacific Steamship Company, San Francisco, Cal. The *Elder* has recently been completely overhauled and rebuilt.

Jesse W. Reno was awarded recently by the city of Philadelphia, acting on the recommendation of the Franklin Institute, a John Scott legacy medal and premium for the escalator of which he is the inventor.

George W. Morey has been appointed chief engineer, with Deacon Wiseman in command, of the tug *Julia A. Brainard,* for "northern canal" work between Troy, N. Y., and the State Dam, just above Waterford, N. Y.

John W. Allardice, formerly first assistant engineer on the *C. W. Morse,* has been appointed chief engineer of the *Greenport,* of the Hudson Navigation Company, New York, with Paul Maltais as first assistant engineer.

Ambrose van Wie has been apointed chief engineer on the night crew of the tow-boat *William Kinch,* of the Great Lakes Dredging & Towing Company, Detroit, Mich. Captain George S. Walker is in command of the tug.

John Daly has been appointed chief engineer of the United States tug *General Totten,* which is in service on the Hudson River above the State Dam at Waterford, N. Y. Captain George Trei is in command of the boat.

James H. Jenkins, of Stamford, Conn., has been elected to succeed Joseph C. Whitney as president of the Merchants' & Miners' Transportation Company. Mr. Whitney has been with the company since he was eighteen years old.

L. Rickinson, formerly consulting engineer to Messrs. Jacobs & Barringer, of London, will accompany the Imperial Transantarctic expedition as chief engineer of the *Endurance.* Mr. Rickinson is a member of the Society of Marine Engineers.

Felix Nash, who has formerly served as engineer with the Great Lakes Dredging & Towing Company, and also with the Hudson Navigation Company, New York, has been appointed first assistant engineer of the steamer *C. W. Morse,* of the latter company.

Robert Burk, formerly of the Homegardner sandsucker *Alice M. Gill,* has been appointed chief engineer of the tug *Yale* of the Great Lakes Towing Company, succeeding the late Fred Koombs, who died as a result of scalds received from the bursting of a throttle valve on the *Yale.*

John Seemen, formerly of the sandsucker *Kelley's Island,* has been appointed engineer of the *Alice M. Gill.*

Herbert Sharp has been promoted from the sandsucker *Clinton* of the Kelley's Island Lime & Transportation Company to the post of chief engineer of the *Kelley's Island* of the same company.

August Schenk, formerly of the steamer *Edward Recor,* of the Kelley's Island Lime & Transportation Company, has been promoted to the sandsucker *Clinton* of that company.

John Guckert, formerly assistant engineer of the steamer *Albert Y. Gowen,* of the Kelley's Island Lime & Transportation Company, has been promoted to the position of chief engineer of the steamer *Edward Recor* of the same company.

Obituary

John P. Holland, inventor of the submarine boat, died on August 12, at his home in Newark, N. J., from a severe attack of pneumonia. Mr. Holland was seventy-one years of age and leaves a wife, three sons and a daughter. Mr. Holland first began to think seriously of a submarine boat while in Europe when the news came of the battle between the *Monitor* and the *Merrimac.* From that time until 1898, when a submarine torpedo boat constructed by him was tested successfully in New York harbor before a committee of Government representatives, Mr. Holland devoted his entire time and energy to the development of this type of boat.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,100,705. DEVICE FOR STEADYING SHIPS. THOMAS C. FORBES, OF LOS ANGELES, CAL., ASSIGNOR, BY MESNE ASSIGNMENTS, TO SPERRY GYROSCOPE COMPANY, A CORPORATION OF NEW YORK.

Claim 3.—The combination with a body of a steadying device comprising, a fly-wheel support mounted to oscillate through wide angles on an axis lying generally in the plane of motion to be counteracted, a fly-wheel of relatively smaller weight than that of the body journaled in said support with its axis extending transversely of the axis of said support and transverse to the axis of said body, means for tending to hold the fly-wheel in the mid position of its oscillation and means for rotating said fly-wheel whereby the gyroscopic reaction of the oscillating support directly steadies the body. Thirteen claims.

1,099,998. SUBMARINE SIGNALING APPARATUS. JOSEF SCHIESSLER, OF BADEN, NEAR VIENNA, AUSTRIA-HUNGARY

Claim 8.—In a signaling apparatus, a submarine sound receiver, an electric circuit containing two adjustable windings, a core common to both of them, and an incandescent winding adjacent said receiver, an independent amplifying circuit containing a winding on said core, an adjustable condenser and adjustable resistance and an incondescible resistance cooled by a current of air across said circuit and in parallel with the condenser and adjustable resistance, a telephone circuit including a telephone, in inductive relation to the amplifying circuit, a tuning fork in proximity to the telephone, a clock, and mechansm operated by the tuning fork to stop the clock. Eight claims.

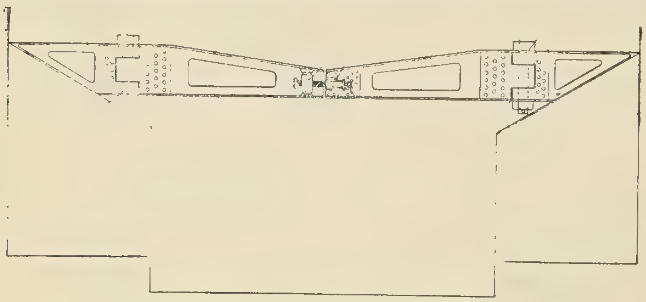
1,100,954. OUTBOARD MOTOR-SUPPORT. AUGUSTE ARTHUR CAILLE, OF DETROIT, MICH.

Claim 1.—In combination with a boat having a pointed stern, a deck carried thereby, a bracket secured to the deck, a pair of gripping members each adapted to engage with one side of the end of the boat, an outboard motor support carried by the gripping members, and means connected to the bracket on the deck, whereby the gripping members may be brought into engagement with the side of the boat. Ten claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

11867/1913. PORTABLE CROSS-BEAM FOR SHIPS. J. R. WIGHAM, OF 4, VALEBROOK GARDENS, SUNDERLAND, AND G. H. JOHNSON.

Claim.—According to this invention portable cross-beams for ships are constructed in two halves or members of steel, preferably in the form of girders, the outer ends being larger than the inner ends, and provided with hinge eyes connected to corresponding eyes on brackets on



the ship's frame by a bolt, to form a hinge joint at each end of the members so that they can each be swung round to open or to close the beam, stops being provided to limit the extent of opening. For securing the inner ends two swivel nuts on one member are engaged by screw-threaded bolts sufficiently long to engage in housings on the other member.

5763/1913. ELECTRICALLY GOVERNING THE SPEED OF ENGINES AT SEA. A. W. FITHIAN, 59, HARROGATE ROAD, CHAPEL ALLERTON, LEEDS.

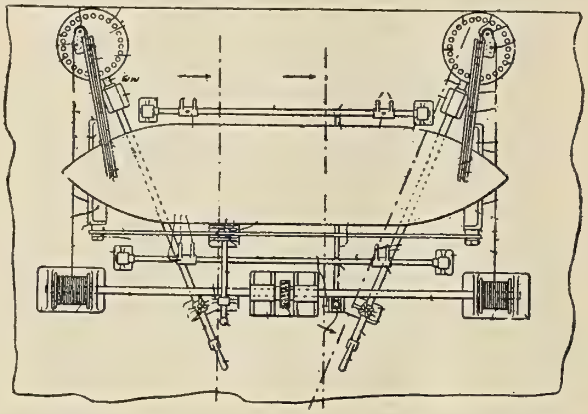
Claim.—By means of a gravity controlled rheostat the current passing round the winding of an electro magnet, the core of which is attached to the moving portion of a balanced throttle valve, is varied gradually by the motion of the ship causing the throttle valve to close and open gradually according to the variation of load imposed on the engine due to whether the propeller is entirely immersed in the water or not, thus causing the engine to run at more or less a constant speed.

1505/1913. ELECTRICALLY OPERATED STEERING GEAR. THE BRITISH THOMSON-HOUSTON COMPANY, LTD., OF 83 CANNON STREET, LONDON, E. C.

Claim.—Mechanism for operating ship's steering gear or the like comprises the following elements: A controller adapted to be operated by the steering wheel through differential gearing, a motor adapted to operate the rudder or other device, and to return the controller to its "off" position, the motor being supplied with current from a motor generator set, the field of which is varied by means of a rheostat whose arm is operated from the shaft of the motor generator set. The circuit of the field and rheostat are completed when the controller is moved from its "off" position. An electro-magnetic clutch is adapted to connect the rheostat arm with the shaft of the motor generator set when the controller is moved from the "off" position, and a switch opens the circuit of the clutch when the arm has reached the limit of its travel, a magnet retaining the arm in this position until the controller is reurned to its "off" position.

6524/1913. SHIP'S BOAT RAISING AND LOWERING GEAR. T. A. SCOTT, 15 FAIRFIELD ROAD, SUNDRIDGE PARK, BROMLEY, W. KENT.

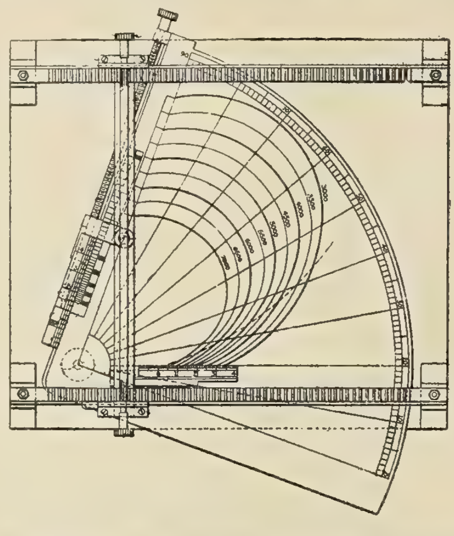
Claim.—A boat raising and lowering gear comprises the following elements in combination: Davits with mechanism for positively and independently turning them about their perpendicular axes, fall-drums



with mechanism for operating them independently of the davits, pivoted chocks with means for simultaneously turning them to, and maintaining them in, the upright or operable position and turning them therefrom to free the boat, and gripes with mechanism for simultaneously engaging and disengaging them, the whole being arranged in such manner that the primary or initial elements of the respective operating mechanisms are assembled midway between the davits to provide a central point of control or operating station.

11,283/1913. INSTRUMENT FOR INDICATING THE RIGHTING ARMS AND OTHER PARTICULARS RELATING TO THE STABILITY OF SHIPS. S. B. ROLSTON OF 11 BOWLING GREEN, WHITEINCH, GLASGOW, SCOTLAND.

Claim.—This is an instrument for indicating the righting arms and other particulars relating to the stability of ships, comprising a plan of curves plotted to indicate the B. R. for various displacements of a vessel, an indicating pin the position of which shows the centre of gravity of a vessel and which can be adjusted in position relatively to the plan



of curves, and a bar or the equivalent for use in conjunction with the pin and mechanism for effecting relative movement between the plan of curves and the bar such that the latter at all times represents a vertical drawn through the center of gravity of the ship. The plan of curves is in the form of a pivoted graduated quadrant upon which the pin is adjustably mounted, a slotted bar being engaged by the pin and being caused to move in a parallel direction whilst the quadrant is movable in an angular path.

2,837/1913. A HYDRO-MECHANICAL STEERING APPARATUS FOR SHIPS. J. PATTERSON, OF SCOTIA ENGINE WORKS, 130 ELLIOT STREET, GLASGOW, N. B.

Claim.—Ships' steering apparatus made according to this invention comprises the following elements: A constantly-running constant delivery, mechanically-operated pump of any convenient form, a system of valves controlling the direction of flow from that pump alternatively to a storage tank and to hydraulic cylinders operating the rudder, a friction clutch device, operated by the usual hunting gear, such and so operatively connected between a constantly-running shaft and the valve system that it causes the valves of the system to be moved oppositely as the hunting gear moves oppositely from mid-position, and means for permitting the continued movement of the hunting gear away from mid-position after it has moved the friction clutch into engagement in one or other direction. One claim.

International Marine Engineering

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Navigation Laws Suspended

In accordance with the provisions of the emergency measure enacted by Congress soon after the outbreak of the European war, admitting foreign built ships owned by American citizens or corporations to United States registry for foreign commerce, the President of the United States issued on September 4 an executive order providing that all foreign built ships admitted to American registry under the emergency act may retain the watch officers employed thereon for seven years from the date of this order, and that such watch officers shall be eligible for promotion. Any vacancy occurring among such watch officers within two years from the date of this order may be filled without regard to citizenship, but any vacancies which occur after the two-year limit shall be filled by a watch officer who is a citizen of the United States. The President also suspended for two years the provisions of law requiring survey, inspection and measurement by officers of the United States for foreign built ships admitted to United States registry under the emergency act.

Foreign Built Ships Registered

Up to September 20, twenty-four foreign built vessels, having an aggregate tonnage of 100,820 gross tons, had been transferred to American registry and preliminary papers were being prepared for the admittance of twenty-seven other vessels of 106,360 gross tons. The first corporations to take advantage of the emergency measure were the United Fruit Company of Boston, which is placing twenty-five of its vessels, aggregating 117,000 gross tons, under the American flag, and the United States Steel Products Company, which is the export subsidiary of the United States Steel Corporation, which has applied for American registry for nine of its steamships. This emergency act has imposed no hardships upon the American shipbuilding industry nor upon American shipowners. On the other hand, it has eased the situation for American owners who have been operating vessels in the foreign trade under foreign flags, and especially for those whose ships were flying the flag of a belligerent nation. But as a means of providing for a permanent expansion of the American foreign merchant marine, it cannot be looked upon with favor. With the amount of idle tonnage available on account of the rapid falling off of foreign commerce, some more definite policy based upon the conditions which are likely to prevail after the war is over will be required before new steamship companies can enter the field and assume the burdens of American registry with confidence of success in competition with foreign shipowners.

Geared Turbines

Innovations in marine machinery are usually met with a cold shoulder, until after several years of service they have proved conclusively that the claims made for them are well founded. Mechanical gearing for marine turbine machinery for the propulsion of ships is no exception. The theoretical advantages of this system of propulsion are obvious. The characteristics of the turbine and the propeller are well known. One is more efficient at high speeds, the other at low speeds, and the compromises that have necessarily been made in adapting one to the other for direct turbine drive have seriously militated against the application of the turbine to certain classes of vessels. As an alternative the introduction of mechanical gearing would appear to be ideal, provided its construction can be accomplished in such a manner as to insure a high efficiency of transmission and unquestionable durability under the trying conditions of service on board ship. How successfully mechanical reduction gearing has been developed for marine work can be seen from the installations recorded elsewhere in this issue, and the possibilities of its future application are strikingly illustrated.

Security of Marine Mortgages

An unnecessary hindrance to the upbuilding of the American merchant marine exists in the lack of protection afforded by the United States laws to bonds or mortgages on American vessels engaged in foreign trade. Recently one of the shipyards on the Atlantic coast was given an opportunity to build half a dozen large freight steamships for use in foreign trade, under the condition, however, that bonds on the ships be taken over by the shipbuilding company. After consultation with bankers in Boston, New York, Philadelphia and Baltimore, representatives of the shipbuilding company found that it would be impossible to secure financial support for this enterprise for the reason that the laws of the

United States do not protect such securities. As a matter of fact, it would be possible for the owner of a vessel, bonded in this manner, to take the ship beyond the three-mile limit outside the coast of the United States to a foreign port, sell the ship and withhold the money represented by the bond issue, without being held liable for this amount by the United States laws. Such conditions militate against the upbuilding of the American foreign merchant marine, although the difficulty might easily be overcome by the enactment of a law providing that no American ship shall be sold or transferred in whole or in part to a subject or citizen of a foreign nation so long as there exists against the vessel any mortgage or lien, and that in the event of any such sale the vessel should be forfeited to the United States, without prejudice, however, to any mortgage or lien which might exist against the vessel. The enactment of such a law would be a simple matter of protection to the floating property of American citizens, and in view of the present increase of the American foreign merchant marine this matter should receive immediate attention by Congress.

State Control of Ports and Waterfronts

At the third annual convention of the National Association of Port Authorities, held in Baltimore September 8-10, at which practically all of the important ports in the United States, including those on the Great Lakes, were represented, some interesting papers on various phases of port construction, finance and administration were read. Among them was one by Mr. B. F. Cresson, Jr., chief engineer of the New Jersey Harbor Commission, on the subject of State control over ports and waterfronts, with special reference to public control, ownership and operation. At the last convention of this association the consensus of opinion appeared to be in favor of some form of public control over ports, waterfronts and terminal facilities, and experience in localities where this has been in practice seems to emphasize its correctness. Private ownership and control in many of the larger European ports have given way to public ownership and control, and in some cases public operation of port facilities has been successfully conducted.

Mr. Cresson pointed out that there is no question about the success of the ports of Montreal, New Orleans and San Francisco, which are not only under a large degree of public control and ownership, but also under a considerable degree of public operation. At the ports of Boston, New York, Philadelphia and Baltimore on the Atlantic coast, and at Los Angeles, Seattle and Portland on the Pacific coast, as well as at certain other ports, public ownership has, to some extent, been practiced, although public operation of port facilities has not been attempted to any great extent.

Transportation companies which own and operate waterfront terminals are themselves under a large degree of public control. The Interstate Commerce Commission and the various State commissions exercise control over private transportation rates and services, and this extends over the terminal facilities privately owned and operated on the waterfront. In fact, there is scarcely any business, corporation, or industry or any public utility that may be said to be free from a certain degree of public control. As practically the only chance for a transportation company to create a monopoly in water transportation is by monopolizing the waterfront at terminal points, the public has a decided interest in the ownership, layout, use and operation of the waterfront at points where the transfers of commodities between land and water carriers can advantageously be made.

Decline in Foreign Commerce

An indication of the extent to which foreign commerce was affected during the first month of the war is shown by the reports published by the Bureau of Statistics at Washington for the imports and exports of the United States for the month of August. The August exports of merchandise amounted to less than 72 percent of the exports in July and were only 59 percent of the exports in August last year. No single month since the summer of 1909 has showed such a small total of merchandise exports for the United States. The items which showed the greatest decline were cotton, mineral oils and meat products; breadstuffs showed a slight increase.

Imports showed a smaller decline than exports. The imports for August amounted to 81 percent of the imports in July and 94 percent of the imports in August a year ago. Of the imports, 61.8 percent entered free of duty, as compared with 50.9 percent in August, 1913, and 54.3 percent in August, 1912. The greater loss in exports was due probably to the fact that many of the ships with cargoes for this country were on the high seas at the time war broke out, and therefore reached this country in August, while the blockade of foreign trade was felt in the export trade as soon as war was declared.

In England, according to the British Board of Trade reports, both imports and exports declined rapidly in August. The month's imports were 24 percent less than a year ago and the exports 45 percent less. Two-thirds of the decline was evidently due to the stoppage of trade with the Continent, the principal item being manufactured products. The supply of raw materials was also cut down materially, although slight increases were shown in raw cotton and metallic ores other than iron. There were also satisfactory increases in the imports of grain and flour.

Along with the decline in foreign commerce, the shipbuilding industry in England has suffered to a considerable extent. On the Clyde, for instance, the output from the shipyards in August was the lowest for the month since 1886. The disturbed state of shipping, due to heavy war risks, has, of course, greatly retarded the production of new vessels, and added to this is the fact that recently work has been concentrated on naval vessels.

How greatly the foreign commerce of the world can

be deranged by war in Europe is shown by the fact that the United States, the United Kingdom, Germany, France and the Netherlands each offer a market for over a billion dollars' worth of foreign products. Great Britain buys $3,000,000,000 (£615,000,000) worth of foreign products, about 20 percent of which is from the United States; Germany, $2,500,000,000 (£513,000,000), with 15 percent from the United States; France, $1,500,000,000 (£308,000,000), of which 11 percent is from the United States, and the Netherlands, which is an important center for the transshipment of foreign goods, nearly $1,500,000,000 (£308,000,000), in which American goods figure to the extent of about 10 percent. Manufactures form 80 percent of the exports from the United Kingdom, 76 percent of the exports from Switzerland, 65 percent of the exports from Germany, 58 percent of the exports from France, and 47 percent of the exports from Austro-Hungary, while Canada, Central and South America, Australia, New Zealand and South Africa, all of which are important markets for manufactures, send large quantities of foodstuffs and raw materials to Europe in exchange for manufactured products. With war in progress in Europe it is evident that new sources of supply must be found, even though the demand for manufactured products is temporarily lessened.

Naval Losses

Notwithstanding the widely divergent views of extremists, which are always heard when the relative values of different modes of modern naval warfare are discussed, the advocates of the submarine are finding much to support their opinions in the relatively few encounters that have taken place since the European war began. Although only minor naval engagements have so far taken place and the reports of these are fragmentary and by no means complete, nevertheless the character of the encounters would indicate that submarine warfare is bound to be an important factor in future naval conflicts. The torpedo has become a far more accurate and effective weapon than it was ten years ago; the range and speed of the submarine boat have greatly increased, and in the meantime means for protecting the ordinary surface warship from under-water attack have advanced but little, if at all, although the subject has received more careful consideration of late.

Up to the time of writing, about two-thirds of the British naval losses have been due either to mines or to submarine attack, and the German naval forces have suffered somewhat from the same source. Up to September 23, Great Britain had lost three armored cruisers, three light cruisers and one torpedo boat; Germany had lost five light cruisers, three destroyers, a submarine and two converted merchant vessels, and Austria had lost three cruisers and two torpedo boat destroyers. The most important engagement took place in the Bight of Helgoland on August 28, when a strong force of British destroyers, headed by the light armored cruiser *Arethusa*, a new vessel which had been in commission only a few days, decoyed several German light cruisers and destroyers out into the open sea, and with the aid of a formidable squadron of battle cruisers, succeeded in sinking the light German cruisers *Mainz* and *Ariadne*, the *Köln* and two destroyers. A later and more disastrous engagement took place in the North Sea on September 22, when a single German submarine sank the British armored cruisers *Cressy*, *Hogue* and *Aboukir*, sister ships commissioned in 1899 and 1900.

Three of the other British losses were due to the explosion of mines. The light cruiser *Amphion* was sunk by a mine off the coast of Holland after destroying the German mine layer *Königin Luise*. The torpedo gunboat *Speedy* and the scout cruiser *Pathfinder* were also destroyed by mines in the North Sea early in September. The British cruiser *Warrior* went aground near the Bosporus on September 7, while the cruiser *Pegasus* was disabled by the German cruiser *Königsberg* in the harbor of Zanzibar on September 20.

The German losses, in addition to those in the battle off Helgoland, include the cruiser *Panther*, reported sunk near Bona, Algeria, by French cruisers; the cruiser *Augsberg*, sunk by a Russian torpedo boat in the Baltic Sea; the submarine *U* 15 sunk in the North Sea by the British cruiser *Birmingham*; the light cruiser *Magdeburg*, which went aground in a storm on the island of Oldensholm, at the entrance to the Gulf of Finland, and was destroyed by Russian warships; the destroyer *S* 90, sunk off the Chinese coast by the British destroyer *Welland*, and the light cruiser *Hela*, which was sunk by a British submarine off Wilhelmshaven.

The French navy, while suffering no losses herself, has succeeded in sinking three of the Austrian cruisers, two off Budua, Dalmatia, and one in the Adriatic, while two Austrian warships have been destroyed by mines.

Of the converted merchant vessels which have been in actual conflict Germany has lost the *Königin Luise*, mentioned above, the former North German Lloyd liner *Kaiser Wilhelm de Grosse*, which was sunk by the British cruiser *Highflyer* off the west coast of Africa on August 27, and the *Cap Trafalgar*, which was sunk in an encounter with the British converted merchant ship *Carmania* off the east coast of South America on September 14. The only armed merchantman lost by Great Britain was the *Oceanic*, formerly of the White Star Line, which went ashore on the north coast of Scotland September 9 and became a total wreck.

That light-armored cruisers and armed merchantmen, which must depend upon their speed for protection, should fall an easy prey to armored warships is to be expected. Such vessels have little value as fighting units in a naval engagement and are useful mainly as scouts and commerce destroyers. But that armored warships are equally defenseless against under-water attack, as has been indicated by the early naval losses in the present war, tends to lessen the reliance that has hitherto been placed upon superior gun power as a measure of naval strength.

Geared Turbines for Propelling Vessels

Some Interesting Features of Their Application to the Largest Express Liner—Possible Savings

BY W. W. SMITH

The application of steam turbines to the propulsion of vessels has been exceptionally rapid and successful in spite of the inherent limitations of speed where the turbine is connected directly to the propeller. This is striking evidence of the excellence and desirability of this type of propelling machinery. As is generally well understood, the turbine demands a high speed, whereas the propeller must run at a low speed to attain the best individual and combined efficiencies.

The solution of the marine turbine problem which makes possible all of the natural advantages of the turbine which result from a high rotative speed is the reduction gear. Since the construction and test of a 6,000 horsepower experimental gear by the Westinghouse Machine Company, of East Pittsburgh, Pa., in 1909, which proved the possibility of transmitting large powers through high speed helical spur gears, geared turbines have been used in a number of installations both on land and sea. It is interesting to note that the Westinghouse Company alone has 95,000 horsepower of large reduction gears in service and building for land and marine installations; while abroad, where marine engineering is less conservative, there is about 500,000 horsepower of marine geared turbines built and building.

An examination of the results which have been obtained with geared turbines will be sufficient to convince the most conservative that the next step in the rapid progress in propelling vessels will be the geared turbine. The engineering and commercial advantages are so great that they demand the closest attention. Shipowners and marine engineers cannot afford to ignore such great advantages, which, within a short time, may spell success or ruin in the keen competition of the future.

The advantages of geared turbines can best be illustrated by specific comparison, and for this purpose it will be of especial interest to select the largest and most powerful transatlantic express steamer, because it embodies the very highest engineering skill and achievement. So to speak, it is the last word in marine engineering. The great improvement which may be obtained by the use of geared turbines is most striking. Therefore in the contest for supremacy in speed and power, the next step seems obvious.

Hence, because she is the latest, largest and most powerful steamship afloat, the giant Hamburg-American steamer *Vaterland* will be used for this illustration. It hardly seems possible that much improvement could be made in this extraordinary vessel, yet, as shown herein, her speed could be increased by about two knots by the use of geared turbines.

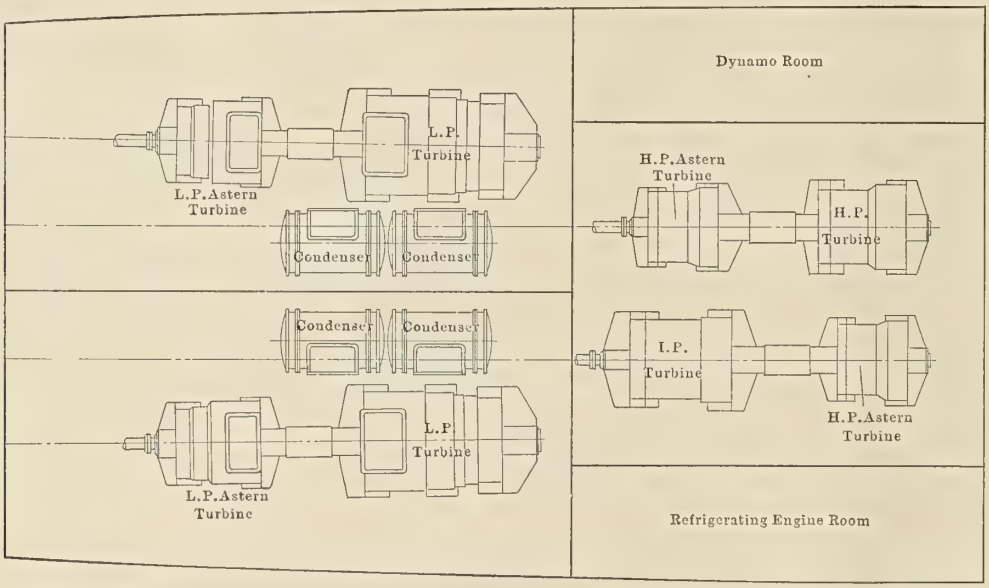


Fig. 1.—Engine Room of S. S. *Vaterland*. Present Arrangement with Direct Turbine Drive

Geared Turbines Applied to the Vaterland

Before proceeding, it should be understood that this paper is not intended as a criticism in any sense. In fact, the engineers and builders of the *Vaterland* deserve the highest commendation for producing this peerless vessel. It is merely intended to point out the great natural advantages of geared over direct drive turbines.

As shown in Fig. 1, the present machinery of the *Vaterland* consists of a high-, an intermediate- and two low-pressure turbines for going ahead, and two high-pressure and two low-pressure astern turbines. The turbines drive four propellers, to which they are directly connected, at 170 revolutions per minute. The proposed geared turbine machinery consists of four geared turbine units, driving the propellers at 130 revolutions per minute. Each unit consists of a two-pinion reduction gear driven by a high- and low-pressure turbine, the latter containing the reversing turbine. A Kingsbury segmental thrust bearing is included in the unit, so that the space

which would otherwise be required for a large collar type thrust bearing is saved. A further saving in space is effected by locating the condenser under the turbines, which is made possible by the reduced size of the turbines and the flexibility of design permitted by the reduction gear.

The propellers of the *Vaterland* have a speed of 170 revolutions per minute. Even this comparatively low speed is too high for the best propeller efficiency. It is hardly probable that it exceeds 60 percent, and with this efficiency the shaft horsepower required for the effective propelling power of 43,200 would be 72,000. To attain the highest propulsive efficiency for this vessel, the propeller speed should be about 130 revolutions per minute, which, for this reason, is the speed selected for geared turbines. At this lower speed of revolution there should be no difficulty in obtaining an efficiency of 65 percent. In fact, it has been done in a number of recent vessels. With this improved efficiency, the shaft horsepower required for the same effective power would be 66,500—a saving of 5,500 horsepower, or 7½ percent.

While the saving due to improved propeller efficiency is large, it is considerably less than that due to improved turbine economy. With the turbine and propeller direct connected so that both revolve at the same speed, not only is it necessary to sacrifice the efficiency of the propeller, but the efficiency of the turbine as well.

For equal efficiencies in any two turbines, the number of rows of blades is, roughly speaking, inversely proportional to the squares of the respective peripheral speeds of the rotating elements. The peripheral speed of the rotating elements in the turbines of the *Vaterland* is only one-third of the speed common in large turbines used on land. This would mean, to obtain the efficiencies common to the latter, the former would require approximately nine times as many rows of blades, which would make a machine of prohibitive length. To maintain the same speed of revolution and increase the peripheral speed of the turbines of these vessels to the point common in land practice, the rotors would have to be nearly 40 feet in diameter, which is manifestly beyond the shadow of possibility.

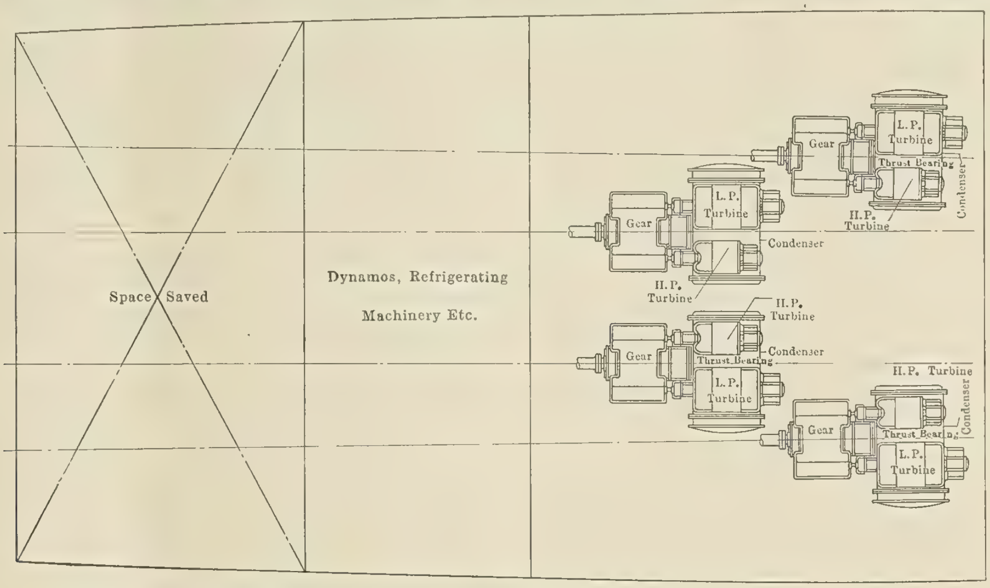


Fig. 2.—Engine Room of S. S. *Vaterland*. Suggested Arrangement with Geared Turbines. Floor Space Saved in Engine Room About 30 Percent

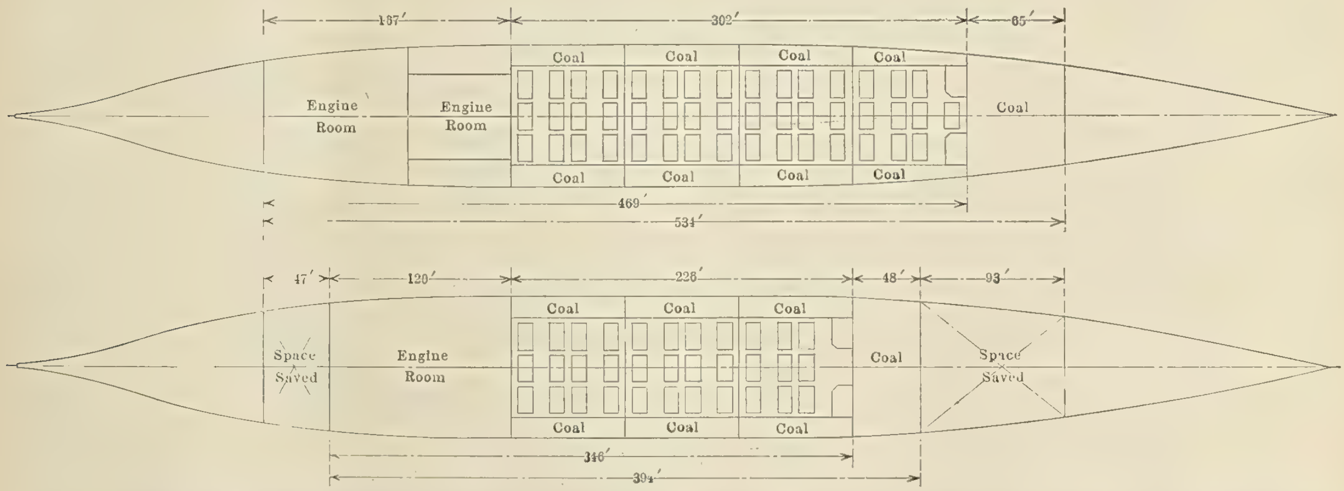


Fig. 3.—Upper Plan, Present Boiler and Machinery Space S. S. *Vaterland*. Lower Plan, Boiler and Machinery Space Required with Geared Turbine Machinery. The Saving in Boiler Capacity and Space Due to Use of Geared Turbines Is More Than One-Fourth

The speed of the present turbines is 170 revolutions per minute, whereas the speed (mean) of the geared turbines is 1,725 revolutions per minute, or about ten times as great. From the best information obtainable, it is believed that the steam consumption of the *Vaterland's* turbines cannot be less than 11.8 pounds per shaft horsepower per hour, while it has been demonstrated beyond question that in turbines of the same capacity operating at speeds which the reduction gear makes possible for marine service, the steam consumption will not exceed 9.0 pounds per shaft horsepower per hour, a saving of 24 percent. This saving, together with that due to the improved propeller efficiency, makes a total reduction in steam consumption of 30 percent for the turbines only, and 28 percent for all machinery. (See table.)

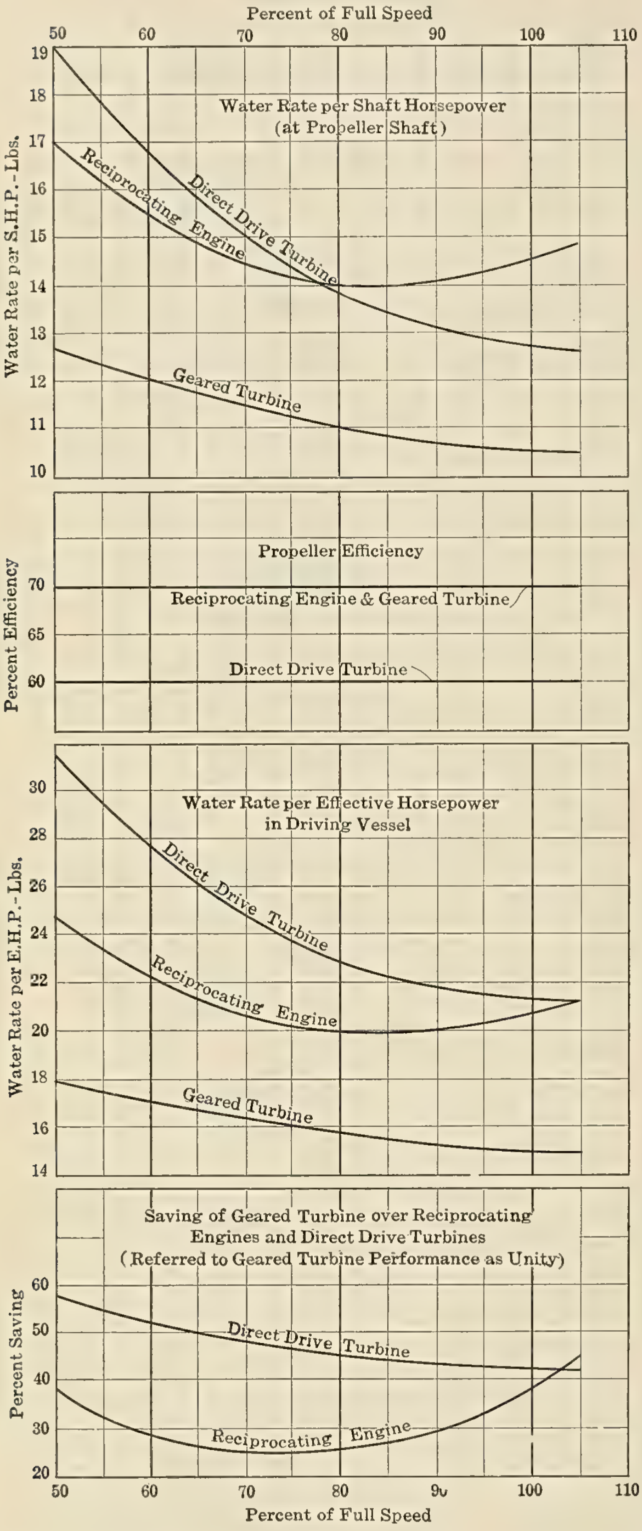


Fig. 4.—Comparison Between the Performances of Reciprocating Engines, Direct Drive and Geared Turbines for a Battleship of 21 Knots and 28,000 Shaft Horsepower, Based on Trial Data of Recent Battleships. (Steam Pressure, 250 Pounds; Vacuum, 28½ Inches)

Geared Turbines Applied to Lusitania

As the machinery of the *Lusitania* resembles very closely that of the *Vaterland,* it will be of interest to note the actual results obtained in service. The following data were obtained from a paper by Mr. Thomas Bell, read before the Institution of Naval Architects, April 9, 1908, and published in International Marine Engineering, August, 1908:

Speed in knots	25.4
Revolutions per minute	190
Effective horsepower	33,000
Shaft horsepower	68,850
Propulsive efficiency—E. H. P./S. H. P.	48 percent
Steam consumption, in pounds, per shaft horsepower-hour of main turbines:	
For turbines only	12.77 pounds
For auxiliaries	1.69 pounds
For all machinery	14.46 pounds
Steam consumption per effective horsepower-hour:	
For turbines only	26.6
For all machinery	30.0
Coal consumption, in pounds, per shaft horsepower-hour	1.43
Coal consumption per day	1,050 tons
Coal consumption per voyage of 3,100 nautical miles	5,390 tons
Actual evaporation of boilers, pounds of steam per pound of coal	10.1
Steam pressure, pounds, gage at turbine	145
Vacuum in inches of mercury referred to 30-inch barometer	28
Feed-water temperature, degrees F.	165

Geared turbines in the *Lusitania* would effect even a larger saving than in the *Vaterland.* Under the above conditions, geared turbine machinery should give a steam consumption of 10.0 pounds per shaft horsepower and a propeller efficiency above 60 without difficulty. This represents a water rate per effective horsepower of less than 16.7 pounds, and a saving over the above performance of over 9.9 pounds, or 37 percent.

Possible Savings

The effect of reducing the steam consumption by one-fourth is far-reaching. Primarily, it means that only three-fourths of the present boiler power is required, or that 13 of the 46 boilers could be omitted. And, furthermore, there is a corresponding reduction in condensers and auxiliaries. The total reduction in weight of machinery would be about 40 percent, or about 3,000 tons, which would represent a saving of about $700,000 (£143,000) in the first cost of the machinery installation.

Due to the reduction in the weight of machinery and coal, and the space required therefor, the cargo capacity would be increased by about 5,300 tons, which would represent an additional earning of about $600,000 (£123,000) per year. The maximum possible earning would be considerably more, or over $1,500,000 (£308,000).

The coal consumption would be reduced more than one-fourth, or about 330 tons per day. With coal at $3.25 (13/6½) per ton, the saving per voyage would be $6,700 (£1,370), and per year about $162,000 (£33,200).

Due to the reduction in the boiler power and coal consumption, the number of the fire room force would be reduced about one-fourth, resulting in a saving in wages and subsistence which would further reduce the operating expenses by about $31,300 (£6,420) per year.

Due to the smaller machinery installation, and its less first cost, the interest, insurance, depreciation, repairs, etc., would be reduced proportionately, or by about $105,000 (£21,500) per year.

Thus it is seen that the total saving per year would be

about $898,000 (£184,000), which, when capitalized at 6 percent, would represent a value of $15,000,000 (£3,080,000). Hence from a financial viewpoint, it is obvious that geared turbines are a most profitable investment. In fact, when this saving is based on the cost of the geared turbines alone, the interest rate which they would pay on the investment would be about 300 percent, or they would pay for themselves in about four months.

If greater speed would be regarded as more attractive than the possible economies mentioned above, it is easy to see that with the present boiler capacity and with the same coal consumption, geared turbines would develop about one-fourth more power, making a total of 90,000 shaft horsepower, which would increase the speed by about two knots, or from 23.5 to 25.5 knots, and reduce the time of passage (from Hamburg to New York) by 12 hours. Thus the *Vaterland* would be not only the largest, but also one of the fastest express steamers.

Of course, the *Vaterland* can at present make more than 23½ knots by forcing, and likewise with geared turbines the speed could be increased according to steam supplied. For the above comparison, the normal full speed conditions were selected for obvious reasons.

If, instead of the above, it were considered desirable to keep the same speed and cargo capacity, but to obtain the benefits of geared turbines by reducing the weight of machinery and hull, and, as a result, the displacement and effective horsepower, the advantages in favor of geared turbines would be found to be substantially the same. In fact, this is only another way of expressing the same comparison. The saving in a vessel of such large power is naturally very great, and while the actual saving which could be effected in smaller vessels is relatively smaller, the percentage of saving is about the same and of no less importance to the owner.

The saving in space which can be effected by the use of geared turbines is shown in Figs. 2 and 3. In addition to the higher efficiency of the geared turbines which results from their higher speed, they are very much smaller, which greatly simplifies their construction and operation. The weight of geared turbines, including the gears, is about one-fourth of that of the large slow-running machines. As the units and parts to be handled are much smaller, the facilities for the inspection and repairs of geared turbines are better. For example, the weight of the largest rotor, the low-pressure, of the *Vaterland* is 135 tons, whereas the largest rotor of the geared turbines would weigh but 11 tons, and could therefore be handled with comparative ease. The total length of blading is reduced from about 122 miles in the direct-drive to about 12 miles in the geared turbines—a reduction of over 90 percent.

In the Westinghouse turbine, the steam is expanded to a considerable volume in nozzles, and the energy due to this expansion is absorbed in an impulse wheel having two rows of moving blades. When superheated steam of high-pressure is used, it is confined in the nozzles, where it is expanded and very much reduced in pressure and temperature, so that the casing of the turbine is never exposed to the high-pressures and temperatures which cause distortion, resulting frequently in blade troubles. As a considerable portion of the total energy in the steam is given up in the impulse wheel, there is considerable reduction in the length of the rotor, giving a short, stiff rotor, which effectually prevents vibration.

An important advantage of the compact and substantial construction of geared turbines is that they can with perfect safety be started cold and brought up to the full speed at once. In naval vessels particularly this is a matter which is often of the highest importance. With turbines directly connected to the propeller shafts, the lengths and diameters of the rotors and casings are such that in order to prevent distortion from unequal heating and expansion, it has been found necessary in practice to bring all of the turbine machinery to the normal working temperature as nearly as possible before it may safely be set in motion. In large vessels this warming process requires several hours. The smaller dimensions resulting from the higher speed of geared turbines give a sturdier construction in which the tendency to distortion is reduced to a negligible minimum. In case of emergency, the steam, even though it carries with it considerable water

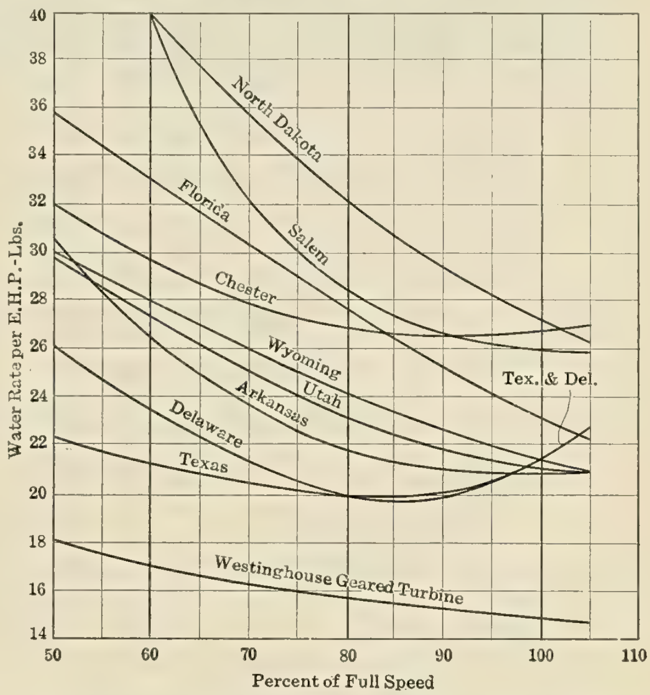


Fig. 5.—Comparison Between Water Rates per Effective Horsepower of U. S. Battleships and Westinghouse Geared Turbines Operating Under Same Conditions. Data from Official Trials (Turbines Only; Auxiliaries not Included)

of condensation, may be admitted to cold turbines, and the full speed attained in about a minute.

By locating the condenser under the turbine, which is made possible by the use of geared turbines, an exceedingly compact unit is obtained. As the steam passes directly into the condenser, the exhaust pipe and the consequent drop in pressure are eliminated. As the turbine drains by gravity, water cannot accumulate, and hence this cause of stripping the blading and of corrosion is eliminated.

Loss of Power in Reduction Gears

The highly economic performance of geared turbines is only made possible by the exceedingly small loss in transmission through the reduction gear. It has been found from tests that the loss is between one and one and one-half percent. This means that the loss in each reduction gear proposed for a vessel similar to the *Vaterland* would be about 200 horsepower, or less than 1,000 horsepower for all four gears.

As the superiority of the helical reduction gear to other methods of speed reduction lies principally in its greatly superior efficiency, it will be of interest to compare the losses in the various systems. From the best information available, it is believed that the losses in the

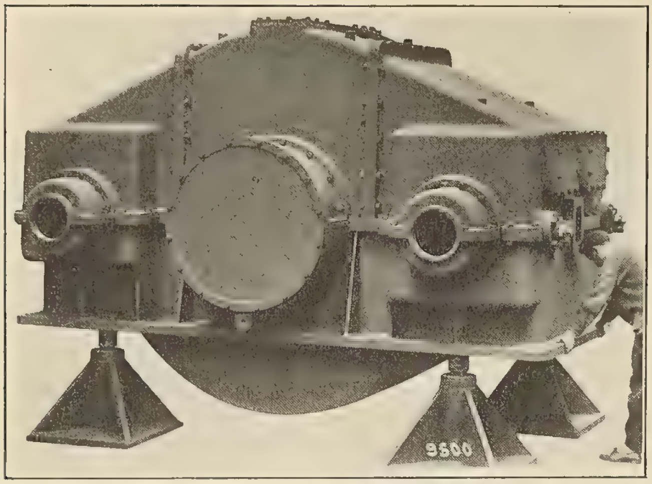


Fig. 6.—Reduction Gear for U. S. S. *Melville* Erected in Builders' Shop. Revolutions per Minute, 1,400 to 110; Shaft Horsepower, 4,000; Diameter of Gear, 95 Inches; Diameter of Pinions, 7½ Inches; Weight, 64,000 Pounds

electric and hydraulic systems of speed reduction cannot be less than 8 percent and 10 percent respectively. Hence the loss of power with electric drive would be 5,600 horsepower, and with the hydraulic 7,200 horsepower, as compared with 800 for the helical gear. The saving of five or six thousand horsepower is of importance, not only because it represents considerable reduction in the cost of operation, but also, as should be clear from the above, because of the reduction in boiler capacity, auxiliaries, etc., in consequence thereof.

The mechanical operation of the gear is not a matter of speculation. The ability of the reduction gear to transmit large powers safely and efficiently has been conclusively demonstrated on land and sea by over 70 gears built by the Westinghouse Company. These gears have proved entirely reliable under varied and severe operating conditions. Most of them are used for large direct current generators and operate under considerably more severe conditions than those on board ship. In many cases the units have been kept in practically continuous service for months, and subjected to frequent short circuits which instantly increase the load to several times the normal full load, thereby imposing shocks and strains on the gear much more severe than ever experienced in marine service. They have operated successfully under the existing service conditions, which in many cases were unfavorable, and where they have received but little attention. It has been found that there is no vibration and that the operation of the gears is very quiet, the noise being negligible. In every case the teeth have taken a brilliant mirror-like polish, which forms a dense,

COMPARISON BETWEEN GEARED AND DIRECT-DRIVE TURBINES FOR EXPRESS STEAMER VATERLAND

	Direct-Drive Turbines	Geared Turbines	Actual Saving	Percent Saved
1. R.P.M. of propellers for 23½ knots	170	130		....
2. R.P.M. of turbines—H. P	170	1,800	......	....
3. R.P.M. of turbines—L. P	170	1,650	......	....
4. Number of reductions—H. P	......	13.8	......	....
5. Number of reductions—L. P	......	12.7	......	....
6. Propeller efficiency—percent	60	65	.....	....
7. Horsepower, effective for 23½ knots	43,200	43,200	......	....
8. Horsepower, shaft for 23½ knots	72,000	66,500	5,500	7½
*9. Steam consumption per S.H.P. hr. lbs.—turbines	11.8	9.0	2.8	24
10. Steam consumption per S.H.P. hr. lbs.—auxiliaries	1.8	1.5	......	....
11. Steam consumption per S.H.P. hr. lbs.—all purposes	13.6	10.5	......	....
*12. Steam consumption per I.H.P. hr. lbs.—all purposes	12.5	9.65	......	....
13. Steam consumption per E.H.P. hr. lbs.—turbines	19.7	13.8	5.9	30
14. Steam consumption per E.H.P. hr. lbs.—all purposes	22.7	16.2	6.5	28
*15. Coal consumption per S.H.P. hr. lbs	1.51	1.17	......	....
16. Coal consumption per I.H.P. hr. lbs	1.39	1.08	......	....
17. Coal consumption per day—tons	1,165	835	330	28
18. Coal consumption per voyage of 3,520 miles—tons	7,270	5,210	2,060	28
19. Coal consumption per year (24 voyages)—tons	174,600	125,000	49,600	28
20. Weight of main turbines (and gears)—tons	2,600	500	2,100	81
21. Weight of all other machinery—tons	4,500	3,600	900	20
22. Weight of all machinery—tons	7,100	4,100	3,000	42
23. Weight of coal required (bunker capacity)—tons	8,200	5,900	2,300	28
24. Weight of machinery and coal—tons	15,300	10,000	5,300	34½
25. Space, floor, occupied by turbines and gears—square feet	3,574	1,760	1,814	51
26. Space, floor, length for all machinery—feet	534	394	140	26
*27. Space, volume for all machinery—cubic feet	1,516,000	1,121,000	395,000	26
28. Turbines, weight of largest—tons	350	33.5	316	90
29. Turbines, weight of largest rotor—tons	135	11	124	92
30. Turbines, number of blades	750,000	160,000	590,000	79
31. Turbines, number of miles of blading	122	11.3	111	91
32. Boilers, number	46	33	13	28
33. Boilers, heating surface—square feet	203,000	146,000	57,000	28
34. Condensers, cooling surface—square feet	65,000	46,800	18,200	28
35. Fire room force, number of men	360	266	94	26
36. Cost of coal per day (at $3.25 per ton)—dollars	3,780	2,710	1,070	28
37. Cost of coal per voyage—dollars	23,600	16,900	6,700	28
38. Cost of coal per year—dollars	568,000	406,000	162,000	28
39. Cost of fire room force per day—dollars	331	245	86	26
40. Cost per fire room force per voyage—dollars	2,070	1,530	540	26
41. Cost of fire room force per year—dollars	119,000	87,700	31,300	26
42. Cost of machinery—dollars	1,900,000	1,200,000	700,000	37
43. Cost of interest, insurance, amortization, repairs and supplies—dollars	285,000	180,000	105,000	37
44. Earning due to 5,300 tons additional cargo capacity—dollars	......	......	600,000	....

*9. Steam pressure 235 pounds gage; vacuum, 28½ inches. *15. Evaporation, 9.0 pounds. *12. S.H.P.=I.H.P. × .92. *27. Below deck, 4.

Summary of Saving (per Year) Due to Use of Geared Turbines.

Coal	$162,000.00	(£33,200)
Fire room force	31,300.00	(6,420)
Fixed charges, repairs and supplies	105,000.00	(21,500)
Additional earning due to enlarged cargo space	600,000.00	(123,000)
Total saving and increase in revenue	$898,300.00	(£184,000)
Total saving and increase in revenue, per S.H.P.	$12.50	(£2.6)

Capitalized value of total saving at 6 percent—$15,000,000 (£3,080,000).

Note.—The information for the above table was obtained from various sources and is the most reliable obtainable. While some of the values were assumed, it is believed that they agree very closely with the actual. However, it should be understood that the table is based on assumptions and that it is only intended to represent a close approximation.

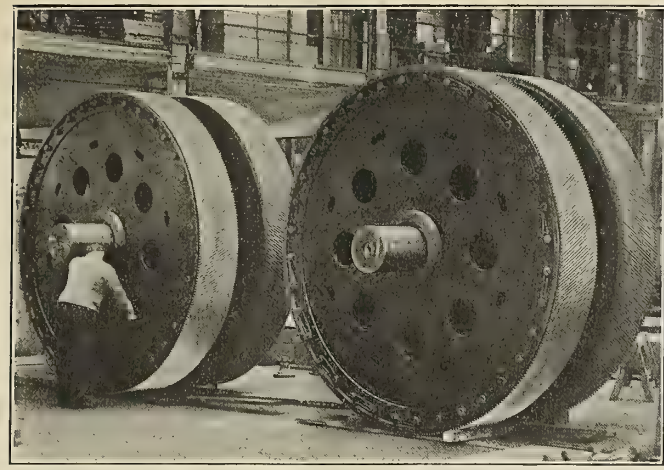


Fig. 7.—Gear Wheels for 35,000 Horsepower Reduction Gears. Diameter of Gears, 120 Inches; Diameter of Pinions, 7 Inches; Revolutions per Minute, 1,900 to 110

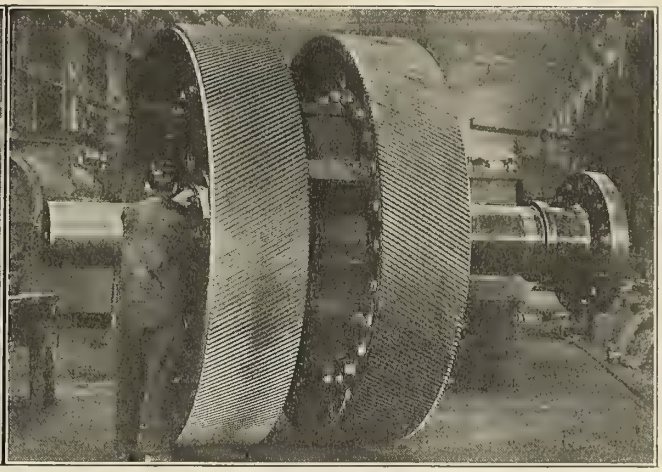


Fig. 8.—Gear Wheels for 6,000 Horsepower Reduction Gear. Revolutions per Minute, 1,800 to 180; Diameter, 100 inches. This Gear Has Been in Successful Operation for Over a Year and a Half

hard skin of exceeding durability on the working surfaces. The wear on the teeth is exceedingly small, and in many cases it has been impossible to detect by accurate measurement of the teeth any wear whatever in gears which have been in service for over two years. It has been demonstrated beyond question that the life of the gear is very long, and that it will exceed the life of the ship.

Transmission of Large Powers

The ability to transmit large powers has been conclusively demonstrated by the fact that the Westinghouse Company have built and operated with entire success the following large gears: Three of 6,000 horsepower, one of 4,000 horsepower, five of 3,500 horsepower, and seven of 2,000 horsepower. Four of the 2,000 horsepower gears have been in service for over three years driving direct

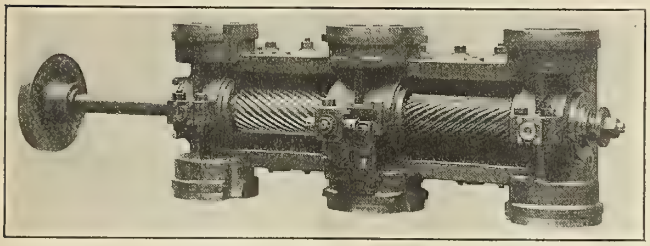


Fig. 9.—Hydraulic Floating Frame with Pinion in Place, Showing Flexible Driving Shaft and Coupling, and the Cylinders Which Support the Floating Frame and Form the Dynamometer for Measuring the Power Transmitted

current generators. Two of the 6,000 horsepower gears, which also drive direct current generators, have been in service for more than a year and a half and have proved most satisfactory in every way. The gears installed on the U. S. S. *Neptune* were tested under all of the various service conditions, and were found entirely satisfactory by the Navy Department. The fact that all of these large gears without exception have operated with entire satisfaction, and that there have been no failures whatever in large gears, should be ample assurance that they are, beyond question, absolutely reliable. They are completely removed from the experimental stage, and, as experience has proved conclusively, they are entirely suited for marine service.

While 67,000 horsepower, such as would be needed for the *Vaterland*, is tremendous, the gears required would be but very little larger than the ones already built, and would be well within the possibilities demonstrated. The power transmitted by each of the eight pinions would be only 8,300, or but 2,300 horsepower more than the 6,000 horsepower experimental gear. If it were desirable, 50,000 horsepower could without difficulty be transmitted

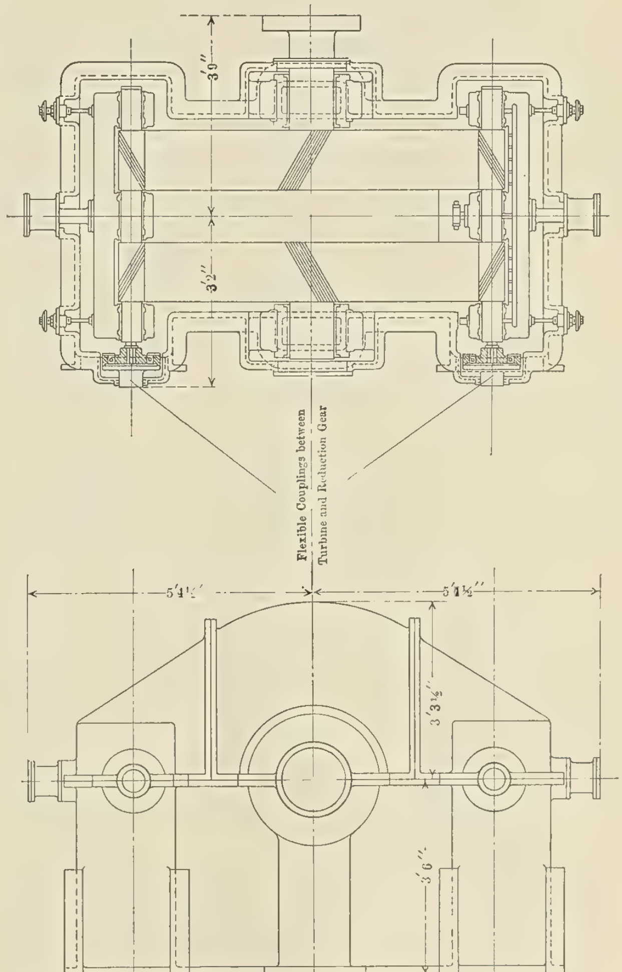


Fig. 10.—Reduction Gear for U. S. S. *Pennsylvania*. Revolutions per Minute, 1,800 to 120; Shaft Horsepower, 1,600; Diameter of Gear, 70 Inches; Weight, 30,000 Pounds

to each shaft, as compared with the 16,600 per shaft in this case. It is plain, therefore, that even the greatest powers which are contemplated for driving vessels can be transmitted through gears without difficulty.

The success of the large gears built by the Westinghouse Company, and their ability to transmit large powers, are due to the hydraulic floating frame, which automatically alines the pinion and the gear under all conditions of load, so as to distribute the load uniformly over the entire length of the broad gear faces, thus avoiding intense local pressure which would otherwise occur. The floating frame gear can be overhauled and assembled quickly by ordinary mechanics with the absolute assurance that it will run perfectly and be absolutely dependable. The hydraulic cylinders which carry the floating frame afford a simple and accurate means of measuring the power. The absence of vibration and noise is due to the fact that there is no metallic connection between the pinion and the gear box, and also that the pinion frame floats on oil, which, due to the entrained air, has a cushioning effect resulting in unusual smoothness and quietness of operation.

Reduction Gears Suitable for Slow Freighters

The savings which may be effected in smaller vessels by the use of geared turbines are no less important than those for large express steamers. In fact, they are a great deal more important because of the greater aggregate power in medium and small size vessels. As compared with reciprocating engines, with which most moderate speed vessels are equipped, the saving in steam and coal consumption in favor of geared turbines is found to be from 15 to 25 percent in most cases. The advantages and financial saving resulting from this improvement in economy should be apparent from the above.

The following specific comparison will illustrate briefly the savings which may be effected in slow speed vessels:

1. *Large Freight Steamer.*—Speed, 14 knots; revolutions per minute of propeller, 90; shaft horsepower, 5,500; steam pressure, 200 pounds.

	Triple-Expansion Engine.	Geared Turbine.	Percent Saved.
Steam consumption for all purposes—			
Steam consumption per I. H. P......	15.0	11.1	25.7
Steam consumption per S. H. P......	16.3	12.1	25.7
*Coal consumption per I. H. P......	1.5	1.1	25.7
Coal consumption per S. H. P......	1.63	1.21	25.7

* Actual evaporation, 10.0 pounds.
Saving in total weight of machinery, 29 percent.

2. *Slow Freight Steamer.*—Speed, 10 knots; revolutions per minute of propeller, 70; shaft horsepower, 2,500; steam pressure, 180 pounds.

	Triple-Expansion Engine.	Geared Turbine.	Percent Saved.
Steam consumption for all purposes—			
Steam consumption per I. H. P......	15.5	11.8	23.5
Steam consumption per S. H. P......	16.75	12.8	23.5
Coal consumption per I. H. P......	1.55	1.18	23.5
Coal consumption per S. H. P......	1.68	1.28	23.5

Saving in total weight of machinery, 27 percent.

From a commercial viewpoint the large savings which may be obtained by using geared turbines are most attractive. No doubt they will be compelling within a short time. In some cases the first cost of geared turbines may be slightly higher than reciprocating engines, but when the savings are capitalized it is found that engines are the most expensive at almost any price. In some cases it is found that it would not pay to put in an engine, even if it were obtained absolutely free.

Advantages of Reduction Gears in Naval Vessels

In naval vessels the military advantages of geared turbines are quite as great and important as are the commercial advantages in merchant vessels. The saving in weight and space required for the machinery makes it possible to considerably increase the gun power or armor protection. In the case of the *Nevada,* for example, the saving in the weight of machinery and coal would make it possible to add another turret, with the necessary ammunition, etc., thus increasing the battery from ten to twelve 14-inch guns, or, in other words, increasing her defensive power by 20 percent.

One of the most important advantages of geared turbines for naval vessels is their high efficiency at cruising speed, in which respect the direct-drive turbine has been found lamentably lacking. This is well illustrated in Fig. 5. These curves would also apply to merchant vessels of about the same power and speed. As the curves for the reciprocating engine are based on the *Delaware* and *Texas,* which have exceptionally efficient engines, they are somewhat better than the average results obtained with this type.

The following comparisons will illustrate the advantages of geared turbines for naval vessels:

1. *Battleship.*—Speed, 21 knots; shaft horsepower, 28,000; steam pressure, 250 pounds.

	Direct-Drive Turbine.	Geared Turbine.	Percent Saved
Revolutions per minute of propellers.	320	125	
Steam consumption in pounds per effective horsepower per hour in driving vessel at full speed...... (Turbines only.)	21.2	15.0	29
Same at cruising speed............	27.8	17.0	38

SAVING IN WEIGHT (TONS)

	Direct Drive.	Geared Turbines.	Actual Saving.	Percent Saved.
Main turbines only...........	650	300	350	54
Other propelling machinery, boilers, auxiliaries, etc.......	910	673	237	26
Ship's auxiliaries (not part of propelling machinery)	500	500	0	0
Propelling machinery only.....	1,560	973	587	37½
All machinery	2,060	1,473	587	28½
Fuel (full capacity)	2,500	1,730	770	31
All machinery and fuel........	4,560	3,203	1,357	30

2. *Destroyer.*—Speed, 30 knots; shaft horsepower, 18,000; steam pressure, 250 pounds.

	Direct-Drive Turbine.	Geared Turbine.	Percent Saved
Revolutions per minute of propellers	600	450	
Steam consumption in pounds per effective horsepower at full speed.. (Turbines only.)	19.5	15.5	20
Same at cruising speed............	28.5	18.0	37

Saving in total weight of machinery ....22 percent
Saving in total weight of fuel ....31 percent
Saving in total weight of machinery and fuel...............28 percent

With geared turbines the additional complication and weight of cruising turbines are not required. With respect to backing power and quick maneuvering, which are very important in naval vessels, the direct-drive turbine has not been entirely satisfactory because of the small propellers and restricted astern power. Because of the large propellers, which "take hold of the water," and the ample backing power which can be obtained in high-speed turbines, the backing and maneuvering qualities of geared turbines are quite satisfactory and practically as good as obtained with reciprocating engines. This is also an important consideration in merchant vessels, especially those which have to be handled around docks.

The advantages of geared turbines for propelling vessels, both naval and merchant, are of the greatest importance. Now that the reduction gear has made it possible to realize the full advantages of the turbines, its rapid adoption seems certain. A few years ago the turbine wiped out the reciprocating engine on land. It now appears that this same stage has been reached at sea, and that here also the turbine will wipe out the reciprocating engine.

The New Niclausse High-Duty Marine Boiler*

Thermal Efficiency of 91.5 Percent Obtained at Combustion Rate of 19.5 Pounds of Coal per Square Foot of Grate Area

BY JULES NICLAUSSE

In the Niclausse boiler all the evaporating tubes are fitted at one end only into the headers, and a perfectly tight joint is insured by metal-to-metal conical joints. The other end is closed by a cap and is carried by a supporting plate. The removal of any tube, either for cleaning or for replacement, is very easily and rapidly effected, so that a shut-down for any cause does not put the boiler out of service for more than a relatively very short time. The tubes being fixed at one end only, expansion or contraction takes place freely, giving complete security against troubles resulting from neglect of this important provision. It will be noticed from Fig. 1 that the old screwed-on lantern end has been suppressed, the tube being now solid drawn throughout, with swellings to form the cones.

As shown in Fig. 1, each header is divided into two compartments by a vertical partition plate, separating the steam and water currents. The current of water flowing through the front compartment of the header is distributed to each evaporating tube by an inner tube contained in the former. Windows cut in the header end of the evaporating tube enable the water to enter and the steam to depart in two distinct currents, so that positive circulation in only one, and that the correct direction, is insured.

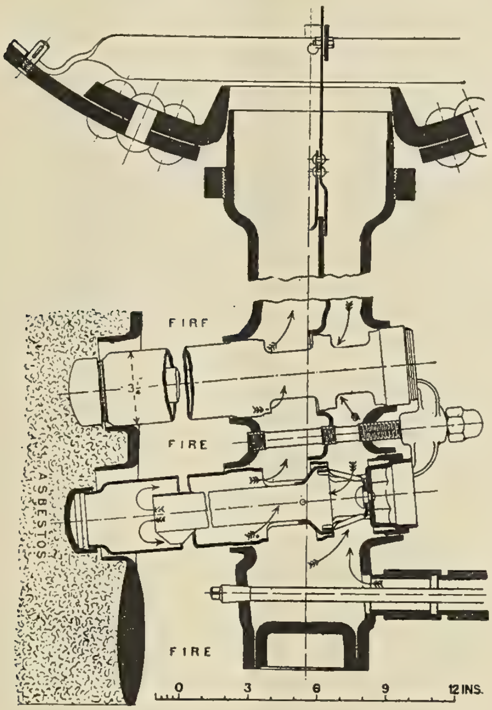


Fig. 1.—Header and Evaporating Tube Ends

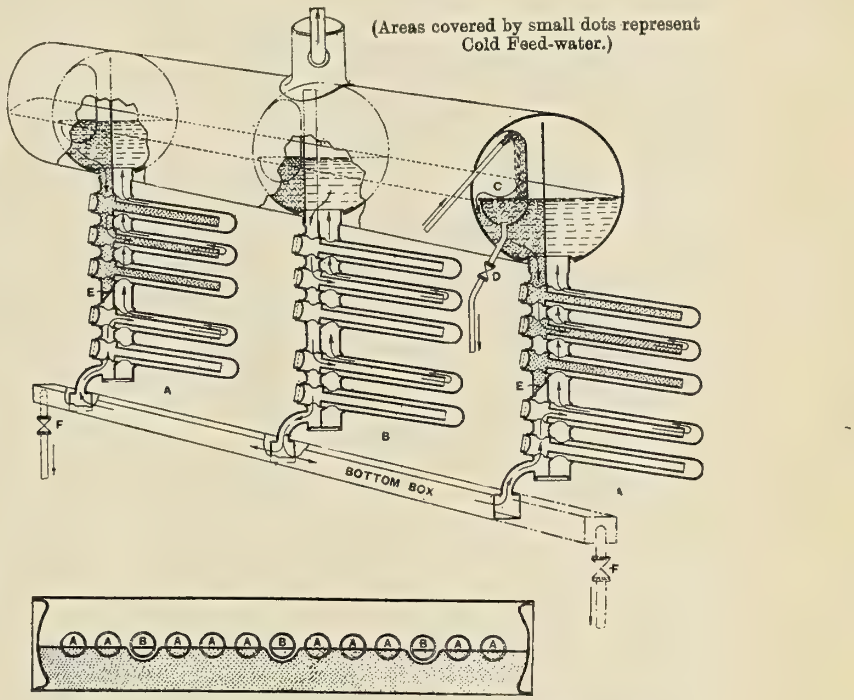


Fig. 2.—Diagram of Water Circulation in Land Type of Boiler

During the last two years a number of improvements have been made in the details of the Niclausse boiler, without affecting the principles of its operation and construction. Some years ago the malleable cast steel curved headers were replaced by headers constructed in solid drawn pressed steel of increased and of rectangular section, and recently the firm introduced a special system of feed distribution to serve the lower tubes, which are those nearest the furnace, and are the principal evaporating tubes. For this purpose, the steam and water drums are divided into two compartments by a longitudinal diaphragm plate in prolongation of the vertical partitions in the headers as shown in Fig. 2; the feed, after passing through a trough *C* wherein carbonates and other impurities are precipitated, and whence they are ejected by means of a blow-down valve *D,* enters at the front compartment, descends the vertical headers for a certain distance determined by a cross diaphragm *E,* passes into the upper evaporating tubes and returns with the steam there produced into the back compartment of the drum, which consequently contains only hot and purified feed. The purified feed then descends by two tubes placed in front of the side walls, in the case of the high-duty boiler, Fig. 3, into a square horizontal header located longitudinally in front of, and connecting by an elbow to the bottom of each of the vertical headers. The upper tubes are therefore fed by relatively cold feed-water, and the bottom tubes by the purified hot feed. The horizontal header also serves as a "bottom box," Fig. 2, whence impurities can also be rejected by blow-down valves *F* fitted at each end of it.

The lower tubes, which are most exposed to the heat of the furnace, consequently receive the feed at boiler steam temperature and free from any impurities which can cause deposit. Any impurities in the feed to the upper tubes are practically harmless, since the temperature of the gases surrounding them is insufficient to form a hard scale.

In the modern land type boilers the system is simplified, without impairing its efficiency, by suppressing the verti-

* Extract from a paper read before the Institution of Mechanical Engineers in Paris, July, 1914.

cal downtake pipes. These are replaced by one header out of every four or five, in which no cross diaphragm is fitted in its front compartment, so that it serves to feed the "bottom box" and the lower tubes of all the headers fitted with the cross diaphragm, while its own lower tubes are served direct. The arrangement will be quite clear from Fig. 2, *A* being headers having the cross diaphragm in their front compartment taking impurified feed from the front side of the drum to feed the upper tubes, *B* being a downtake header taking its hot purified feed-water from the back side of the drum, the division plate therein being suitably arranged for this purpose, as shown at *B* in plan.

In the new high-duty marine type boiler, the firm have still further increased the section of the headers, chiefly in the rear compartment forming the passage for the steam. This is about 4½ times larger than in the modern land type headers. Furthermore, an inclination of 15 percent instead of 10 percent has been given to the tubes, in order to facilitate disengagement of the steam. Also, the outside diameter of the tubes has been reduced from 3 5/16 to 2⅜ inches, a reduction which has been rendered practicable, with complete security against all forms of distress, by the above-mentioned improvements.

The new high-duty boiler is fitted with a feed-reheater placed above the tubes. The water circulates into this apparatus on the contra-flow principle—that is, in the reverse direction to the hot gases. The official tests referred to hereafter show the efficacy of this feed-reheater, as much from the point of view of the feed-water temperature as from that of the chimney-gas temperatures.

The high-duty marine boiler, having no superheater as usually arranged between the tubes in the land type, is fitted with a new system of gas baffling, which doubles the length of the gas flow in the tube "faisceau," ensuring improved utility and efficiency. This comprises plain open-ended tubes laid between the evaporating tubes, forming gas passages, as will be seen from Fig. 3.

All the above improvements were comprised in the test boiler recently tested by the French navy experts. Full dimensions of this boiler are given in Table I, together with a drawing showing its general arrangement, Fig. 3. The tests of this boiler by the committee of naval experts appointed by the French Admiralty, and carried out in September last, comprised:

(1) A six-hour trial at the combustion rate of 19.5 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 13.1 per pound of coal fired, the thermal efficiency being 91.5 percent, and the capacity 20,000 pounds per hour from and at 212 degrees F.

(2) A six-hour trial at the combustion rate of 37 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 11.5 per pound of coal fired, the thermal efficiency being 79.8 percent.

(3) A sixteen-hour trial at the combustion rate of 46 pounds of coal per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 11.4 per pound of coal fired, the thermal efficiency being 79.3 percent, and the capacity 41,000 pounds per hour from and at 212 degrees F.

(4) A four-hour trial at the combustion rate of 28 pounds of petroleum per square foot of grate surface. The evaporation in pounds from and at 212 degrees F. was 15.5 per pound of fuel burnt, the efficiency being 78.8 percent.

(5) A five-hour trial to demonstrate the elasticity of the boiler. Operation took place as follows: Half an hour at the combustion rate of 19.5 pounds per square foot of grate surface; half an hour at the combustion rate of 37 pounds; half an hour at the combustion rate of 46 pounds; one hour at the combustion rate of 49.2 pounds; a quarter of an hour at the combustion rate of 37 pounds; a quarter of an hour stop; ten minutes at the combustion rate of 19.5 pounds; three-quarters of an hour at the combustion rate of 28 pounds with oil fuel; a quarter of an hour at

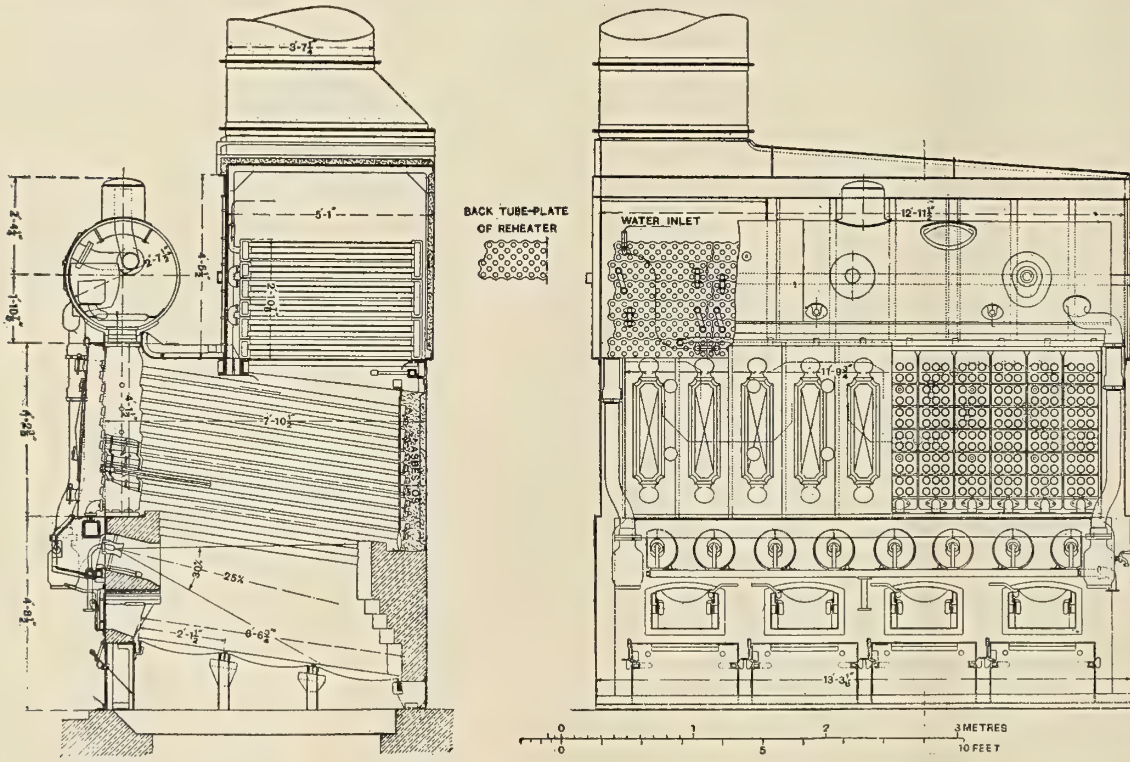


Fig. 3.—High-Duty Marine Boiler for New Battleship *Bearne*

the combustion rate of 19.5 pounds of coal. This trial proved that the boiler made the change from these different rates with perfect success, and without any difficulty.

Further tests were made on January 6 last by a party of English engineers. The results fully corroborated those obtained by the French naval experts.

During the No. 3 trials, the percentage of water entrained was at maximum only 0.9 percent. This was determined by the salt method with the Kennedy apparatus. The maximum temperature of the gases at foot of chimney was only 625 degrees F. during the sixteen-hour test at the combustion rate of 46 pounds per square foot, when the evaporation was 105 percent above the normal. It must be added that the feed-water used was the ordinary town water, which was not in any way treated or purified, and which during the official tests was subjected to an addition of such a quantity of sea salt as to give one degree of salinity to the water in the boiler. Valvoline was also added in the proportion of 175 grammes per ton of coal fired. On the results of the tests made by naval experts in September last, the French Admiralty placed with the firm an order for twenty-one boilers aggregating 36,000 horsepower for the 25,000-ton super-dreadnought *Bearne* laid down on January 1 of this year.

Table I.—Particulars of the Boiler Submitted for Trials by the Navy

The general arrangement of the boiler is shown in Fig. 3. Other particulars are as follows:

Working pressure (gage)	256 pounds per square inch
Number of headers	13
Number of evaporating tubes, upper	300 (thickness, 0.099 inch)
Number of evaporating tubes, lower	156 (thickness, 0.16 inch)
Total number of tubes	456
Cleaning tubes	12
Outside and inside diameter of upper tubes	2.36 inches x 2.16 inches
Outside and inside diameter of lower tubes	2.36 inches x 2.04 inches
Height of headers	7 feet 6 inches
Length of tubes projecting outside the headers	6 feet 7¼ inches
Number of tubes in economizer	780
Length of economizer tubes (outside headers)	4 feet 0 inches
Length of grate	6 feet 6 inches
Width of grate	11 feet 9½ inches
Grate area	77.5 square feet
Heating surface of outer tubes	1,870 square feet
Heating surface of economizer	1,285 square feet
Total heating surface	3,155 square feet

The ratio of outer heating surface of the tubes (neglecting the header surface) to the grate surface is:

Outer surface of evaporating tubes	24.11 to 1
Outer surface of economizing tubes	16.56 to 1
Ratio of total heating surface to grate area	40.67 to 1

Space occupied by boiler = 114 square feet; height to top of dome, 13 feet.

Hourly evaporation per square foot of ground space occupied:

(*a*) At normal load, with rate of combustion of 19.5 pounds per square foot of grate surface = 175 pounds per hour from and at 212° F.

(*b*) At overload, with rate of combustion of 46 pounds per square foot of grate surface = 355 pounds per hour from and at 212° F.

A Reprieve for the Big Fore-and-Afters

The probability of a new lease of life for the big schooners of the Atlantic coast is seen in the recent departure of the five-master *Dorothy B. Barrett* from Norfolk, Va., with a cargo of coal for Seattle, Wash., via the Panama Canal. With fair conditions she should make the passage as quickly as the steamers that have heretofore carried the same commodity through the Straits of Magellan; return with sugar, lumber or some other freight, the prompt delivery of which is not a necessity, and solve the serious problem of the disposition of her class of vessel, of which many staunch specimens have been in danger of being left hopelessly superannuated while yet in the prime of existence.

For many years the huge fore-and-afters of the *Barrett's* type continued to flourish in the protected domestic trade, while foreign-going "windjammers" were being hounded from the seven seas by the encroachments of steam. But then into the coastwise coal trade came the tugs and barges, and later fine steel steamers, many of them lake-built. This summer despairing owners have laid the big sailers up by scores at all the north Atlantic ports, with little hope of their ever finding occupation again unless converted into barges. So the opening revealed by the *Barrett* comes at an opportune time.

It is true that vessels of the *Barrett's* rig are essentially coasters. They lack the squaresail or raffee forward worn by the big Pacific fore-and-afters which regularly go offshore, though the four-master *Haroldine,* built at Weymouth, Mass., when the many-master was a novelty, wore such an innovation, which was removed after she made a few voyages. But the short cut at Panama which halves the length of the coast-to-coast voyage will practically put the fore-and-after on an equal footing with the offshore-going craft. Hereafter she will merely be going coastwise, and Cape Horn will hold no terrors for her.

Moreover, these big coasters have had quite an extensive acquaintance with "Cape Stiff" years before this. The pioneer five-master *Governor Ames,* built at Waldoboro, Me., in 1888, went to San Francisco when new, badly beat several square-riggers which sailed from this side at the same time, and made much better work of it than the Port Townsend four-master *William Nottingham,* which brought a cargo of spars from Puget Sound to Boston a few years ago. The *Ames* was wrecked with a loss of eleven lives on Wimble Shoals, N. C., December 13, 1909.

The *Kineo,* of Bath, the only steel five-mast schooner ever built and still in service, carried a cargo of coal from Norfolk, Va., to Manila and returned with Hawaiian sugar to Philadelphia, also making a couple of voyages in the Pacific before returning. The *Haroldine,* before mentioned, made a successful trip to Melbourne, while the four-sticker *Susie M. Plummer* a few years ago was sold to Pacific owners and ended her days as a derelict recently on the other side.

Big schooners, too, have figured rather extensively in other deep water trades. The *Mary F. Barrett,* a sister ship of the *Dorothy,* not long ago carried a cargo of lumber to the River Platte, as did the five-sticker *James W. Paul, Jr.* Four-masters commonly engage in this trade, and until the last few years did so in that to the West Coast of Africa. The *George W. Wells,* the first six-master built, which was wrecked south of Hatteras September 5, 1913, carried coal from Philadelphia to Havana on her first trip, making a record passage.

The big four-master *Edward T. Stotesbury,* now the *Blanche C. Pendleton,* carried case oil from Philadelphia to Liverpool on her maiden voyage, and the *Medford,* of similar rig, lost in a hurricane at Knight's Key, Fla., a few years since, made her début with a coal freight from Philadelphia to Lisbon, Portugal. The ill-fated voyage of the huge steel seven-master *Thomas W. Lawson* from the Quaker City to London can scarce be quoted as an inducement to owners to embark in offshore trades, since she was lost on the Scilly Isles December 13, 1907.

However, there are afloat on the Atlantic coast to-day 8 six-, 25 five- and 158 four-mast schooners of 259,175 gross tons. Many are not fit to go to Seattle, but many more are, and the *Dorothy B. Barrett* is one of these. She is of 2,088 tons, and was built at Bath ten years ago by Gardiner G. Deering, who also is her owner.

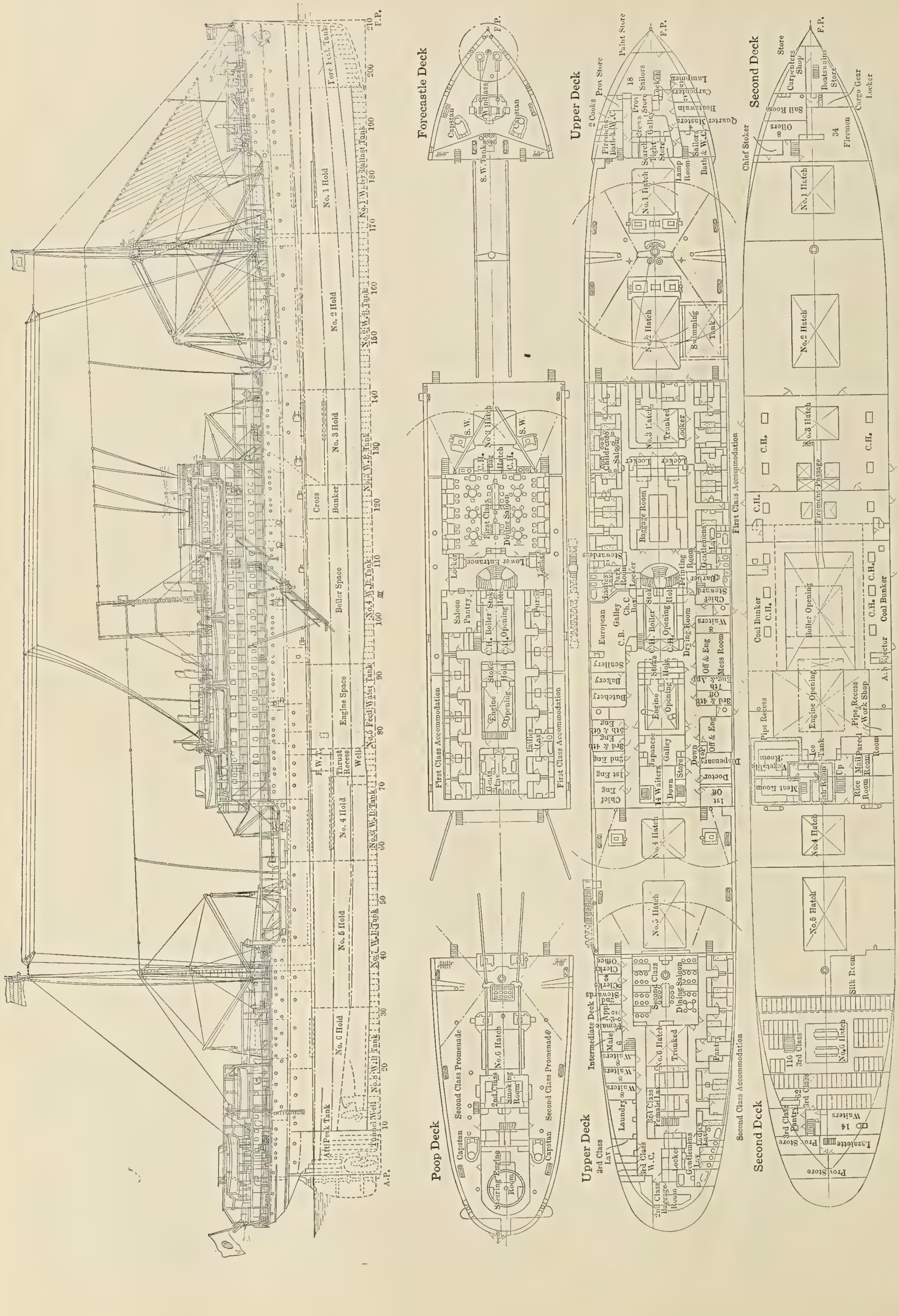


Fig. 1.—Profile and Deck Plans of the *Katori Maru* Built by the Mitsu Bishi Dockyard and Engine Works of Nagasaki for the Japanese Mail Steamship Company, Ltd.

A New 10,000-Ton Japanese Mail Steamship

Description of the Latest Addition to the Japanese Mail Steamship Company's Fleet of Eighty-Three Steamships

The most important shipping company in the Far East is the Nippon Yusen Kabushiki Kaisha (the Japanese Mail Steamship Company, Ltd.), which operates a fleet of eighty-three steamships and maintains regular services from Hong-Kong, Kobe, Yokohama and several other Japanese ports to India and practically all parts of the Far East, to Australia, London, Seattle and Victoria, B. C. The latest addition to this company's fleet is the triple-screw steamship *Katori-Maru,* which was built and engined by the Mitsu Bishi Dockyard & Engine Works, of Nagasaki. The new vessel has the following dimensions:

Length overall	510 feet
Length between perpendiculars	490 feet
Breadth, molded	61 feet
Depth, molded	36 feet 6 inches
Load draft	28 feet
Load displacement	18,750 tons
Gross tonnage	10,512 tons
Trial speed	16.75 knots

As will be gathered from the general arrangement drawing, the *Katori-Maru* has six decks, two of which extend from end to end of the ship. There is a continuous double bottom of 1,817 tons capacity extending from the collision bulkhead to the after peak bulkhead. The hull is divided into six compartments by extra strong watertight bulkheads.

The promenade bridge, upper and main decks contain the first class staterooms for 112 passengers, including suites of rooms, cabins for 56 second class and 8 special third class and 178 bunks for third class passengers.

The first class social hall, smoking room and suites of rooms are situated on the promenade deck. The social hall is of satinwood and smoking room of nara (Japanese oak). They are very tastefully decorated in mixed Japanese and Western style. The first class dining saloon is on the bridge deck, constructed of white oak and very luxuriously decorated. There are seats for 90 passengers at small tables. Just opposite this saloon is a roomy pantry. On the upper deck is the children's saloon, decorated with Japanese paintings. Besides these there are all manner of smaller rooms necessary for long voyages, such as a dark room, consultation room, barber's shop and a laundry. The staterooms are on the promenade, bridge and upper decks. All of them are at the sides of the ship, and there are no inside rooms.

Fig. 2.—Triple-Screw Steamship *Katori Maru* of 18,750 Tons Displacement and 11,700 Horsepower

The second class accommodation is situated aft. The dining room, to seat 44 persons, is plainly yet neatly finished. The smoking room is situated on the poop deck. The second cabins, too, have no inside rooms.

There are 120 small electric ventilating fans in the first and second class quarters. The ship is lighted throughout by electric lamps numbering more than 800 in all. Three arc lamps, one of 16,000 candlepower for a searchlight, and two of 3,000 candlepower are provided.

On the main boat deck the captain's room and officers' quarters are situated forward, and the radio-telegraphy room and Clayton's fire extinguishing apparatus room aft. On each side of the same deck ten lifeboats are placed under Welin patent boat davits. On the after deck is a hospital, and on each side three lifeboats and one temma (a light junk).

The refrigerating machinery, to cool a chamber of 4,600 cubic feet capacity, was made by Messrs. J. & E. Hall, Ltd., of Dartford. The deck machinery includes a Na-

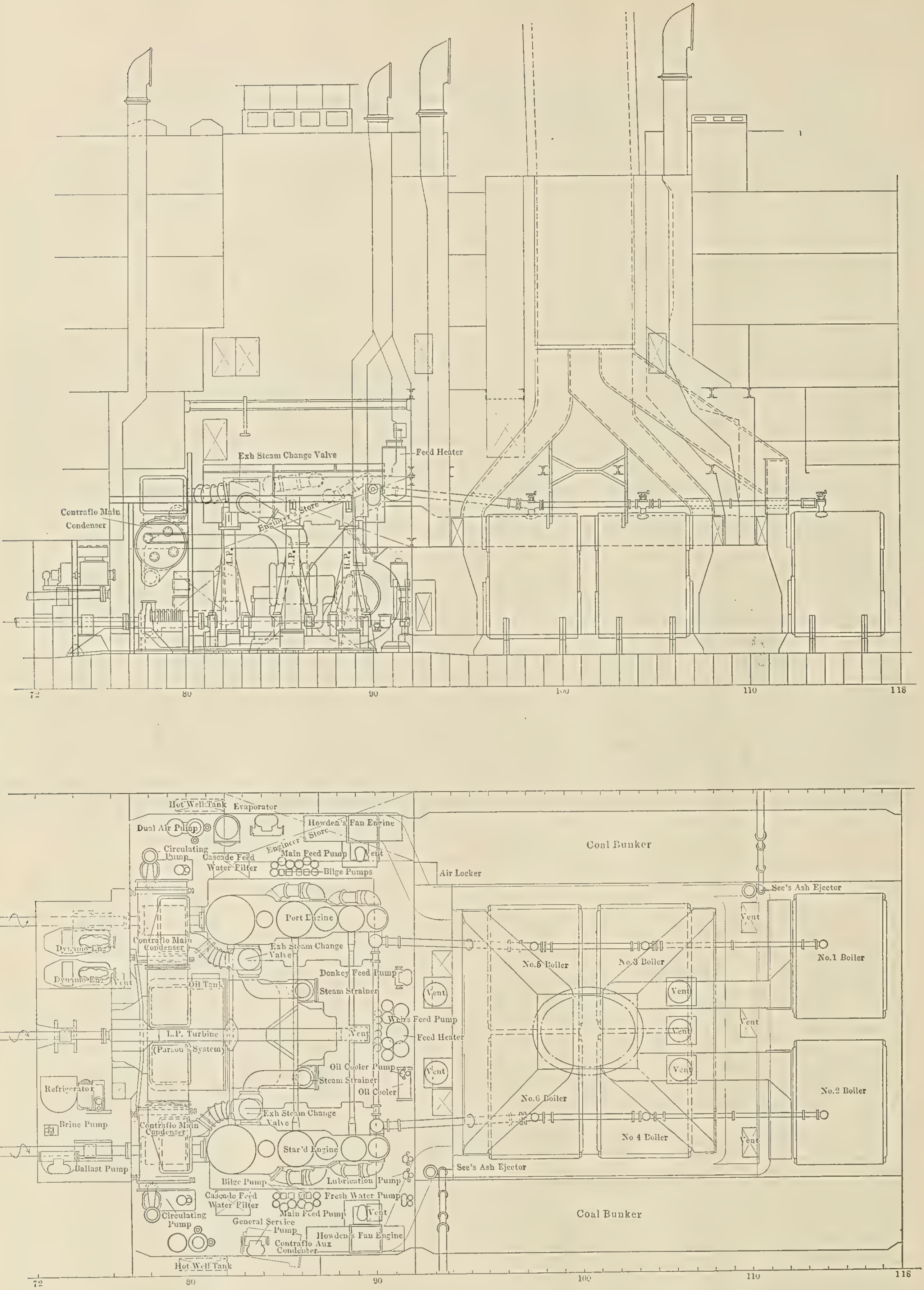


Fig. 3.—Longitudinal Section and Plan of the Machinery Space, S. S. *Katori Maru*. Wing Screws Driven by Triple Expansion Reciprocating Engines and Center Screw by Low-Pressure Parsons Turbine. Total Indicated Horsepower, 11,700

pier's windlass and twelve winches of from 3 tons to 40 tons capacity, six of them being of Wilson's noiseless pattern. A Caldwell's steering gear, with telemotor connection, has been fitted.

The main machinery is composed of two triple-expansion reciprocating engines and one exhaust turbine of Parsons type. The former drive the wing shafts and the latter the center shafts. The aggregated indicated horsepower is 11,700. The diameters of the cylinders of the reciprocating engines are 27 inches, 42 inches and 66

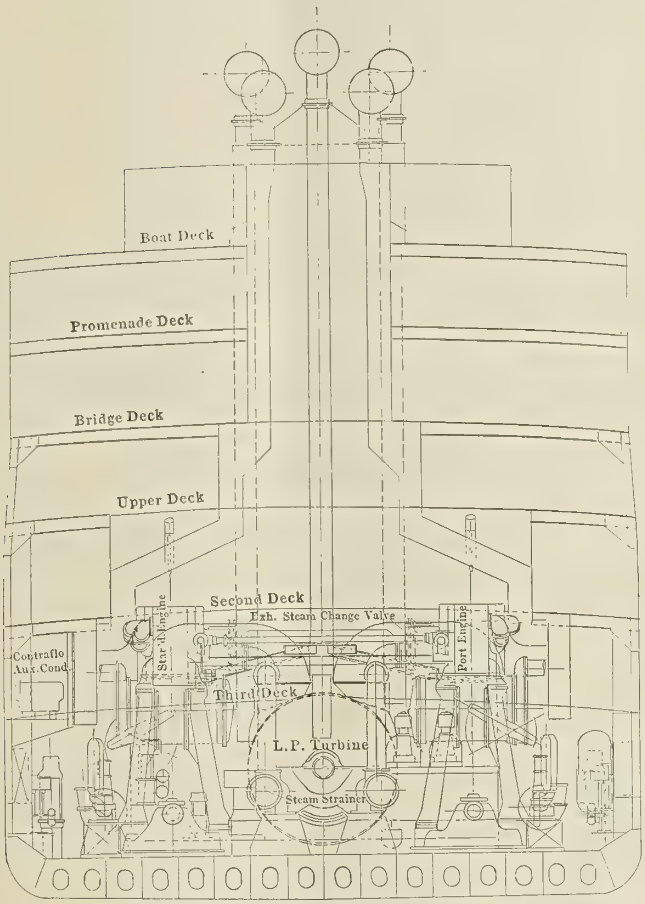


Fig. 4.—Section Through Engine Room

inches, with a stroke of 48 inches. The rotor drum of the turbine is 11 feet 1 inch diameter and 10 feet in length. The main and auxiliary condensers are on the Contraflo system.

Steam is generated by six Scotch boilers, 15 feet 6 inches diameter and 11 feet 9 inches long, working at a pressure of 200 pounds per square inch. The draft is the Howden system.

The *Katori-Maru* was built under the special survey of the Japanese Government surveyors to meet the requirements of the Shipbuilding Encouragement Law, and also to Lloyd's highest class.

Boston's Square=Riggers

Ralph C. Emery, of Boston, Mass., recently sold the barkentine *Allanwilde* to Scammell Brothers, of New York, and the transaction reduced the number of square-riggers owned in Boston to four.

Two of the quartet are barkentines of the Emery fleet. The *John S. Emery* runs regularly in the export lumber trade between Boston and South America, and is commanded by Capt. Davis. She is of 803 net tons and was built at Boston in 1890. The *Kremlin,* built at Bath, Me., in the same year, is employed in the southern coastwise lumber trade in charge of Capt. Leland. Two years ago she was nearly destroyed by fire at Portland, Me., and lately has been rebuilt. She is of 698 net tons.

Boston's last bark, the *Onaway,* is owned by Crowell & Thurlow, who purchased her a few years ago from the Winslow Company, of Portland. She is commanded by Capt. Goldthwaite, and is used at present in the molasses trade between Porto Rico and Boston. The *Onaway* is of 883 net tonnage and was built in 1883 at Yarmouth, Me.

The 1939-ton *Aryan,* the last full-rigged ship built in the United States and the only one now owned on the Atlantic coast, is the property of Eugene P. Carver. In late years she has been in the coast-to-coast trade via Cape Horn, but has recently taken a load of lumber from Puget Sound to South Africa, where she is at this writing. Two years ago she was overdue on a voyage from Baltimore to Seattle with coal, but turned up safely when 154 days out. The *Aryan* was built at Phippsburg, Me., in 1893.

Alteration of Ferryboat Pittsburgh

The ferryboat *Pittsburgh,* of the Pennsylvania Railroad Company, has recently undergone some extensive alterations at the Hoboken shops of that company, for the purpose of providing further accommodations for teams. The vessel is of the double-ended ferryboat type, 200 feet long, 46 feet beam and 15.4 feet draft, and is propelled by two compound engines of 1,800 indicated horsepower. Steam is supplied at 200 pounds working pressure by four watertube boilers.

The alterations represent the removal of the lower cabins, stairways, and upper deck enclosure, so that an additional team gangway on each side of the boat could be provided. In lieu of the inboard bulkheads of cabins, which were removed, the following has been substituted to assist in the support of the upper deck: 9 columns of 6-inch I-beams, 12.25 pounds per foot, and two 6-inch H-beams, 23.8 pounds per foot, and one 6-inch pipe column with cast iron base, forming a wheel guard, on each quarter; and on each end at the center one built column of four angles, 3 inches by 2½ inches by ⅜ inch plate 6 inches wide. The girders, except at ends, are made of 8-inch I-beams, 18 pounds per foot, and at the ends are of four angles 4 inches by 3 inches by ⅜ inch, with plate ½ inch by 9 inches by 13 inches deep. From the center to the end columns, two lattice girders of four angles 2½ inches by 2½ inches by 5/16 inch and 2 inches by ¼ inch lattice. On the side columns, 6 feet from the deck, a lattice stiffener is fitted of two angles 3 inches by 2½ inches by 4½ pounds and 2 inches by ½ inch lattice.

On each side of the outboard combing is a passageway, the whole length of deck, and on each side an iron stairway has been fitted from this passageway to the upper deck, for emergency use only. The outboard coamings have an easy line to facilitate the ready loading and unloading of teams. All of the sides and ceiling of the main deck enclosures were lined with non-inflammable "Neva-split" sheathing. All windows have been removed from the outboard coaming, excepting 20 on each side. Proper lighting facilities for the gangways have been provided by means of ten incandescent lamps on each side. On each end, in addition to the gates, is fitted a ⅝-inch wire cable which is connected to a drum underneath the deck, so weighted as to house the cable when not in use; this cable has been installed principally as a safety device to prevent progress of an automobile improperly started.

The shape of the hull of this boat was very much

adapted to the improvements made—that is, the flare on the sides of her hull will come inboard on the main deck about 1 foot 6 inches from the outboard team gangway coaming, and this, with her general stability, amply takes care of any lists.

The Development of Mechanical Gear= ing for Marine Turbine Machinery

BY ERNEST H. B. ANDERSON *

Rapid progress continues to be made in the development and in the constructional details of mechanical gearing for ship propulsion. At the present time the total shaft horsepower of Parsons geared turbine machinery in vessels actually in service amounts to 62,500, and there is under construction an additional 650,000 shaft horsepower.

At present all merchant vessels in service fitted with this means of drive are operating in Great Britain and the Colonies, but there is being built in the United States 35,000 shaft horsepower of mechanical gearing, all of which is to be driven by Parsons turbine machinery installations for use in the United States Navy or for the auxiliary vessels connected with the fleet. Among the vessels completed abroad, the following may be mentioned and full particulars of the machinery installation, trial trip and service performances may be found in the proceedings of various technical societies or in engineering journals.

Geared Turbine Installations

1. Steamship *Vespasian,* 1,000 shaft horsepower (Institution of Naval Architects, 1910 and 1911).

2. Steamships *Hantonia* and *Normannia,* 5,000 shaft horsepower (Institution of Naval Architects, 1912).

3. Steamship *Cairnross,* 1,700 shaft horsepower (North East Coast Institution of Engineers and Shipbuilders, 1913).

4. Steamships *Curzon, Hardinge* and *Elgin,* 2,500 shaft horsepower (Institution of Naval Architects, 1913).

5. Steamship *King Orry,* 8,000 shaft horsepower (*Engineering,* June 27, 1913).

6. Steamship *Paris,* 14,000 shaft horsepower (*Engineering,* December 5, 1913).

7. Two British destroyers.

The total number of vessels in the mercantile marine fitted and to be fitted with this system of propulsion is now in excess of 40. The Cunard Line has two large vessels for intermediate service in hand, the machinery of which will drive twin screws and each be capable of developing 10,000 shaft horsepower. John Brown & Company, Clydebank, has in hand a large vessel for the Orient Line which will have a machinery installation of 12,500 shaft horsepower. This vessel is being built for mail service between London and Australia, and direct comparisons can be made between the performance of the machinery with sister ships having twin screw reciprocating engines and also one having a triple screw combination arrangement of twin reciprocating engines working in conjunction with a low-pressure turbine. The Anchor Line has a large vessel under construction for

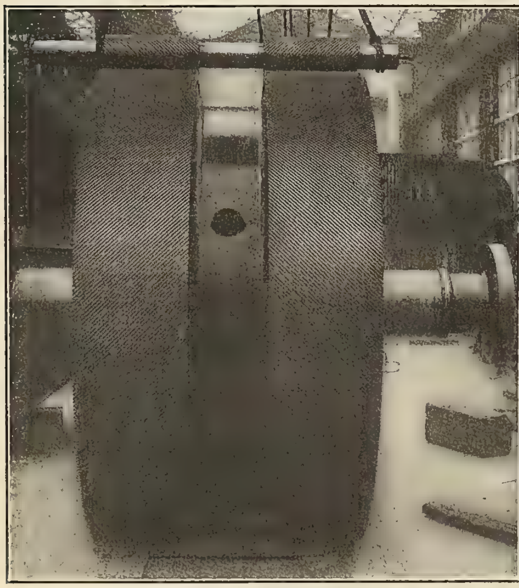


Fig. 1.—Finished Gear Wheel and Pinion

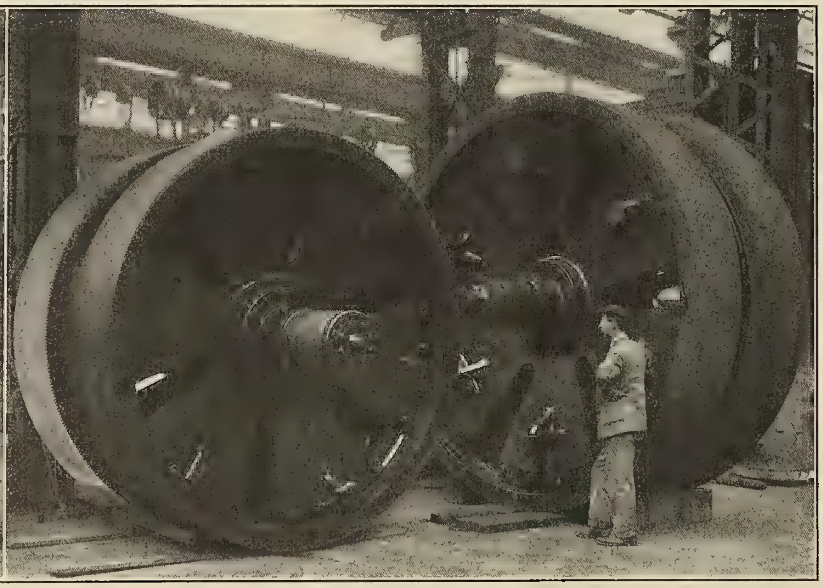


Fig. 2.—Gear Wheels Assembled

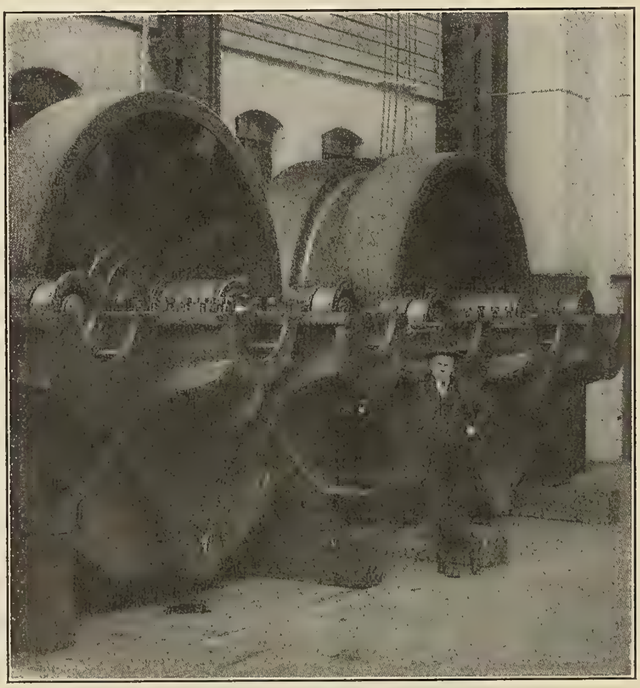


Fig. 3.—Gear Wheels and Pinions Assembled in Casings

* Member Institution of Naval Architects and Society of Naval Architects and Marine Engineers.

passenger and freight business between Glasgow and New York. This vessel will be driven by twin screws, and the turbines and gearing are designed to develop 8,000 shaft horsepower under service conditions. Two vessels are under construction on the Clyde for the Canadian Pacific Railway Company, the machinery in each case being designed for 12,000 shaft horsepower, while the South Eastern and Chatham Railway Company has a high-power geared turbine vessel for mail service between Dover and Calais.

Among others may be mentioned the following:

One cargo boat of 3,600 shaft horsepower of the Brocklebank Line.

One cargo boat of 900 shaft horsepower of Ruys & Company, Holland.

Two vessels of 5,000 shaft horsepower of the Argentine Navigation Company.

Two vessels of 6,000 shaft horsepower of the Nippon Yusen Kaisha Company.

Five ocean-going vessels of the Federal Steam Navigation Company.

Two ocean-going vessels of the Austrian-Lloyd Company.

One ocean-going vessel of the Union Steamship Company, New Zealand.

One passenger steamboat of 2,000 shaft horsepower, building by A. & J. Inglis, and a lighthouse tender.

Fifty-eight war vessels of various types fitted with all-geared or part-geared turbine installations, two of which have all-geared turbine installations in excess of 30,000 shaft horsepower each.

General Design

The following illustrations show the general design of gearing under construction at the present time at the works of The Parsons Marine Steam Turbine Company, Ltd., Wallsend-on-Tyne:

Fig. 1 shows a finished gear wheel and pinion. The approximate diameter of the wheel is 132 inches, and the approximate diameter of the pinion 8 inches, the ratio of reduction being 16.50 to 1. On a vessel fitted with the standard arrangement, a similar pinion is arranged diametrically opposite, the high-pressure ahead turbine driving one pinion and a combined low-pressure ahead and astern turbine driving the other pinion, both pinions being in mesh with the gear wheel.

Fig. 2 shows two sets of gear wheels assembled. One is finished while the other is ready for cutting the teeth in the hobbing machine.

Fig. 3 shows the gears and pinions assembled in a gear case for a merchant vessel, the gear case cover being removed. The turbines are bolted to the facings of the brackets arranged on each side of the lower half of the gear case, and the flanged couplings to which the turbine rotors are bolted are clearly shown in the illustration.

Fig. 4 shows the assembled turbines and gearing. The high-pressure ahead turbine with maneuvering valves is shown at the left bolted to the lower half of the cylinder casing. The combined low-pressure ahead and astern turbine are in one casing on the right. The condenser is placed under this turbine, the flange and bolt holes of the exhaust nozzle being clearly shown in the illustration.

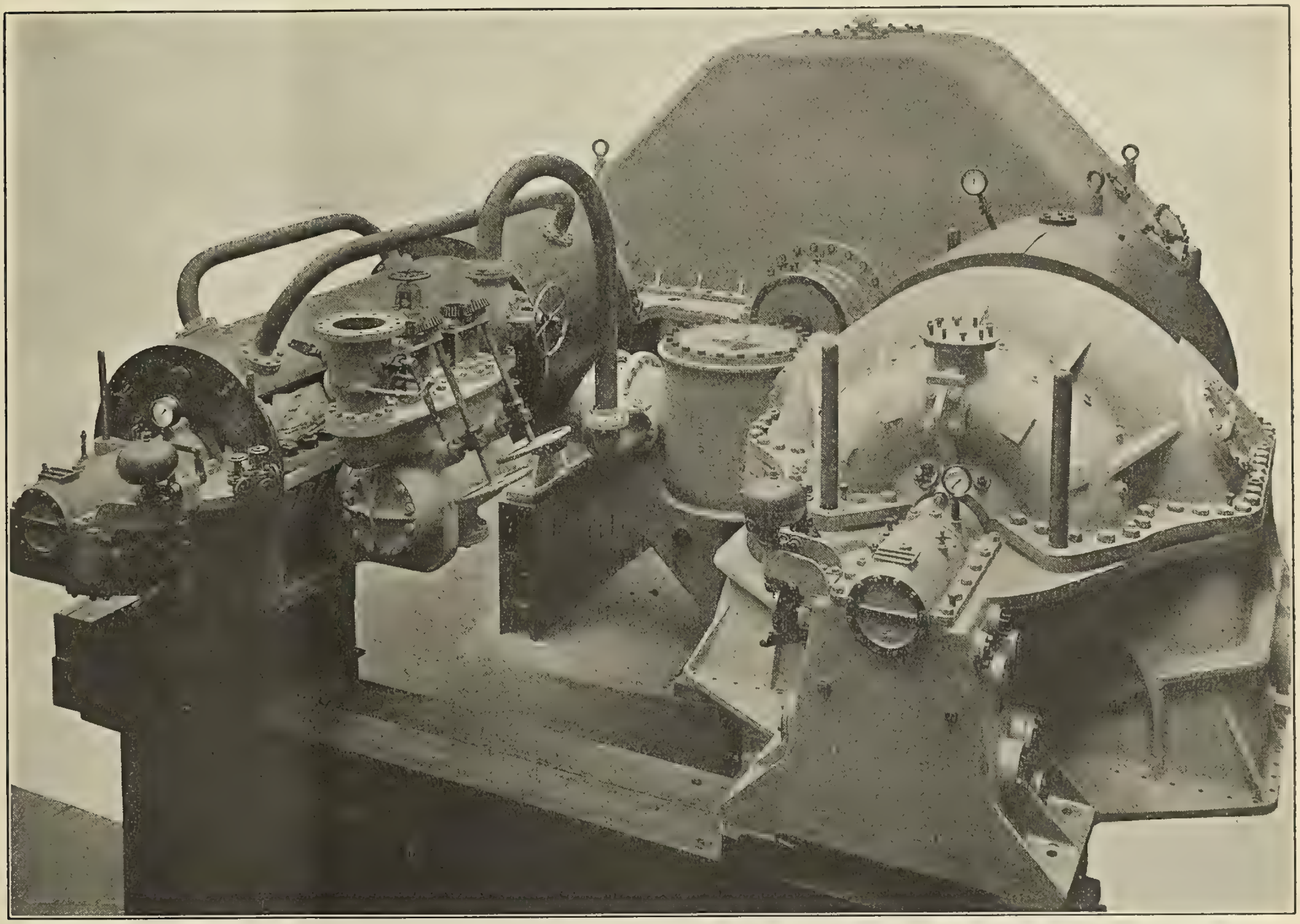


Fig. 4.—High and Low-Pressure Turbines and Reduction Gear Assembled. Astern Turbine Incorporated with Low-Pressure Ahead Turbine

The gears shown in the foregoing illustrations have been designed by Sir Charles A. Parsons, and the teeth have been cut on a hobbing machine, fitted with his latest invention, commonly referred to as the "creep" mechanism. Full details describing this invention and the experiments connected with its design were published in his paper on "Mechanical Gearing for the Propulsion of Ships" read before the Institution of Naval Architects, 1913, an abstract of which was published in International Marine Engineering, June, 1913.

Careful tests and examinations have been made of gears which have been in operation for one or two years, and these tests have shown that the work has been distributed over the faces of the teeth fairly uniformly, and practically no wear can be detected in the teeth of either the gear wheel or pinions. In practice, however, experience has shown that the gears have been responsible for a certain amount of noise, although it has never been objectionable enough for passengers to make complaints, even in the boats on all-night routes, but it was evident that the art of cutting fast running gears had not been perfected. Sir Charles A. Parsons and his colleagues realized that mechanical means would not entirely overcome this difficulty, and that the only true method to provide silent running gearing is in having a very high degree of accuracy in cutting the teeth.

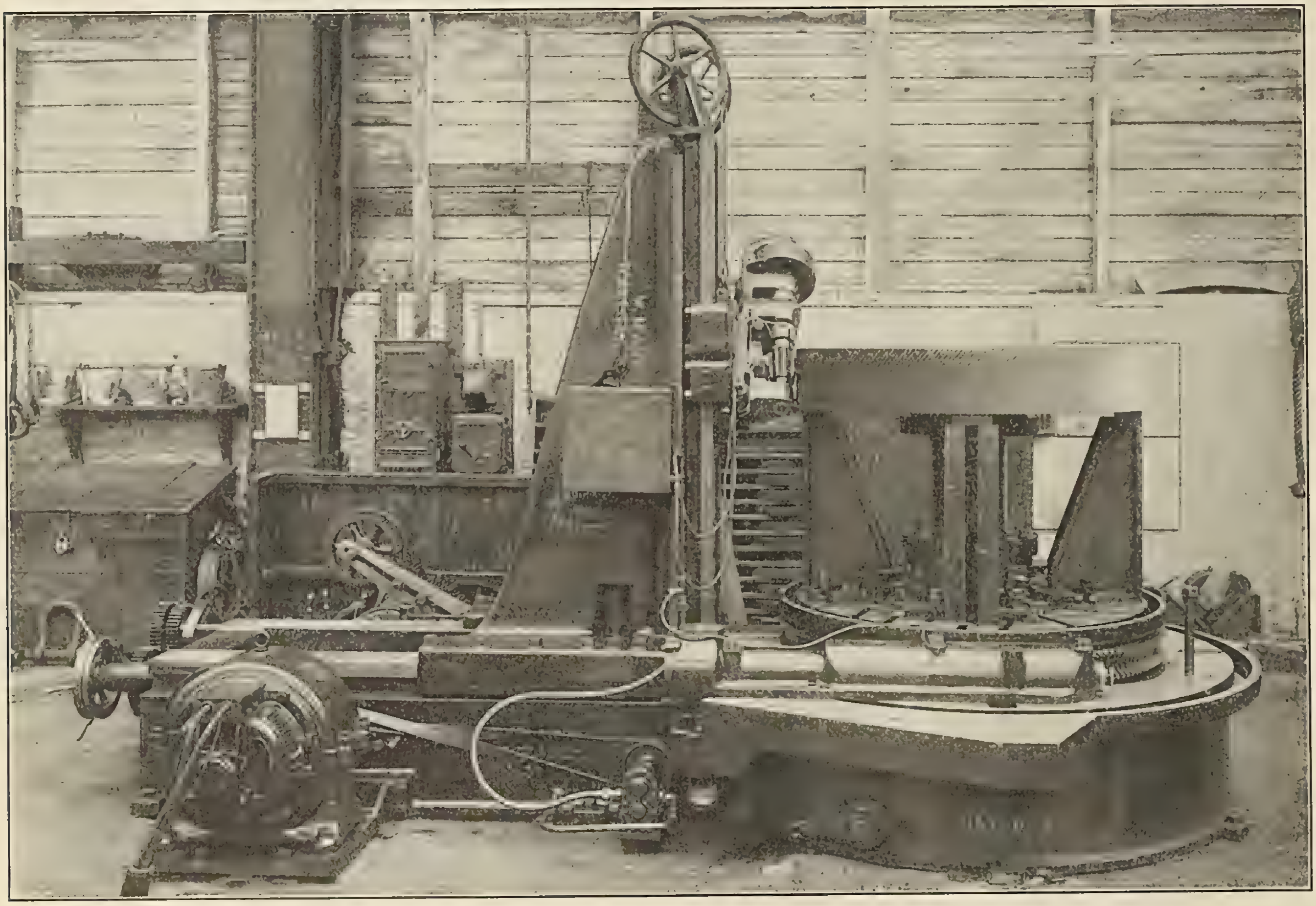


Fig. 5.—Type of Machine Ordinarily Adopted for Cutting Teeth on Reduction Gear

Gear Cutting Machine

Fig. 5 shows an illustration of the type of machine ordinarily adopted for cutting the teeth, in which the work is mounted on a table rotated by means of a worm and worm wheel and to which the gear wheel is permanently attached during the process of cutting. This machine has been in use for upwards of three years, and upon which gear wheels have been cut amounting to a total of 100,000 horsepower.

The explanation for the noise produced in the gears cut on this machine was traced to the parent gear, and it was found to be due to very slight inaccuracies in the teeth, for which the worm and worm wheel drive were responsible. At the present time it is doubtful if a higher degree of accuracy in cutting can be relied on than in the case of this machine, unless by the introduction of multiple worms driving one worm wheel.

The means taken to overcome this difficulty are best described in Sir Charles A. Parsons' own words, quoted from the paper previously referred to:

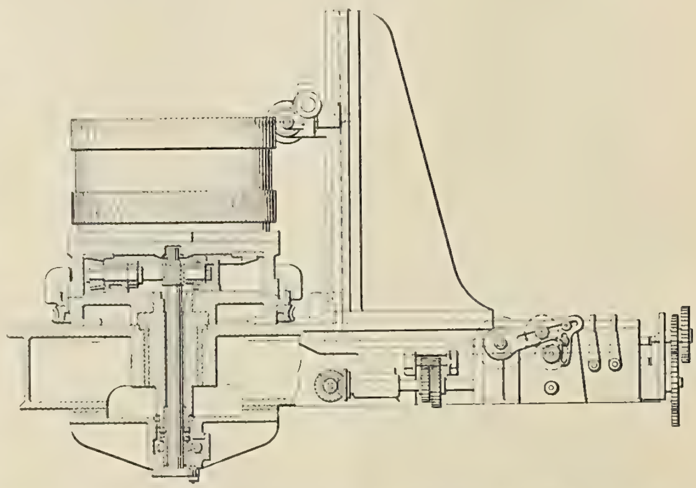


Fig. 6.—Secondary Table Mounted on Original Table of Gear Cutting Machine and Train of Gearing to Give 5 Percent "Creep"

"It will be seen that in the process ordinarily adopted, in which the work is mounted on a table rotated by means of a worm and worm wheel, the latter being attached permanently to the table, the errors will be some function of the angular position of the work, and, therefore, lie in planes through the axis of rotation; and if, as is mostly the case, the errors of the parent gear are periodic, these planes will lie at equal angular intervals, and will come into mesh periodically. Now, it will be seen that if the work is given a small steady advance in relation to the table, the errors, instead of lying in planes through the axis, will lie in spirals around the wheel, and that when put to work they will be obliterated and leave a true wheel.

"Fig. 6 is an illustration of the adaptation of this new principle of cutting to an existing gear hobbing machine. A secondary table is mounted on the original table of the machine and given a creep in advance of 5 percent in relation to it by means of the train of gearing shown, the main worm driving the lower table being driven at 5 percent less speed, so as to secure the same rotational speed as before the creep was introduced.

"While the most important effect of this arrangement is that the errors in the teeth will lie in very oblique spirals around the wheel, resulting in great uniformity in the gearing, at the same time it has also an important effect in reducing the errors themselves."

This article has been written for the purpose of bringing to the notice of ship-owners, shipbuilders and engineers the large amount of marine mechanical gearing which is under construction in Great Britain at this time, the engines of which will drive vessels across the North Atlantic and all over the world by means of steam turbines and mechanical gearing.

Advantages of Geared Turbine Drive

The following advantages have been clearly demonstrated for this new method of ship propulsion, when compared with reciprocating engine machinery:

1. Economy in fuel consumption, varying from 10 to 25 percent, dependent on the type of vessel under consideration.
2. Saving in the machinery weights varying from 10 to 20 percent.
3. Saving in engine room space for large ocean-going vessels.
4. Less liability for broken line shafting, due to the even turning moment of turbine machinery.
5. In a single screw vessel, with the ahead turbines of the reaction type arranged in series, either turbine can be used independently of the other, so that this lessens very greatly any chances of a complete breakdown of the main propelling machinery.
6. Splendid economy of steam consumption is obtained in the reaction type of turbine with moderate boiler pressures, varying from 150 to 175 pounds working pressures, with its consequent advantages of a lighter and safer machinery installation.

Finally, there does not appear to be any limit to the horsepower that can be transmitted through gearing suitably designed for any proposed work.

New Revenue Cutters to be Built at Newport News.—The Newport News Shipbuilding and Dry Dock Company, Newport News, Va., has been awarded the contract to build the two new revenue cutters, bids for which were opened by the Treasury Department on September 1. The successful bid was $396,000 (£81,250) for the two ships, the work to be completed in ten months.

The Determination of Dimensions for Cargo Ships

BY THOMAS GRAHAM, B. SC.

During recent years a large amount of attention has been directed toward the forms of cargo vessels. To a certain extent this has made the determination of actual shape a much easier task than formerly, but it has not placed in the hands of the naval architect a ready and practical method of fixing the dimensions of ships. The determination of dimensions is the first and most important duty of the designer—and certainly it is the most difficult. In many instances the shipowner merely states the deadweight he wishes his new vessel to carry, the speed at which it must be carried and the limiting drafts of the harbors in which the vessel will trade. Now to fix dimensions on so practical an enumeration of requisites always presents a difficulty, no matter how adequate may be the data of previous ships in the possession of the naval architect. And the difficulty exists, not from the lack of information so much as from an absence of some satisfactory method of reducing the "dimension-determining" results to a common rule or formula of application. For instance, if designs are invited for a proposed new ship, the natural procedure is to refer first of all to ships actually built and pick out the one conforming most accurately to the new requirements. Sometimes this may suggest the exact dimensions, but most frequently it only provides an inadequate approximation followed by a process of trial and error, involving calculations of weights, trim and stability until the appropriate figures are obtained.

Now in cargo vessels where, within limits, there does exist much similarity of form and speed, it should not be impossible to establish some empirical formula having an application more or less general to all ships of this kind.

For instance, the identity—

hull weight + machinery weight + deadweight = displacement,

might be wholly expressed in terms of the linear dimensions. Further, two of these dimensions, such as length and depth, might be resolved into terms of the third, breadth, and then the equation would become a function of breadth, and with this determined, experience of ship's proportions could readily infer the length and depth. Returning to the above equation, the hull weight for a finished ship is always expressed as a coefficient of the block number for purposes of comparison with other vessels.

Where C_h is a coefficient hull weight $= C_h \times L \times B \times D$. (1)

But it might be pointed out here that however common and natural a basis of comparison this coefficient may be, it is highly unsatisfactory. Depth for one thing is too fluctuating a measure to introduce into a general formula. It is no uncommon thing to have two ships identical in length, breadth and weight and virtually the same depth, and yet according to this conventional method of comparison, the hull coefficients may be entirely at variance. For instance, a flush shelter deck steamer and a poop, long bridge and forecastle deck steamer might be exactly the same length and breadth and of the same hull weight, and yet on account of the different reckoning of depth the latter type of ship would possess a much higher hull coefficient than the former. In this way, unless vessels are grouped into exactly similar types, the hull coefficient is a precarious and inadequate figure of comparison.

If, however, we take the expression $C_h \times L \times B \times D$ and express it entirely in terms of the breadth, it becomes

$K_h \times B^3$. Here the factor of depth is eliminated altogether because its presence in C_h is canceled by its proportion in B.

Now K_h seems to be a comparatively uniform figure, and Fig. 1 shows values of it plotted on an abscissa of $\frac{L}{B}$ from 7 to 8.5. It will be noticed that the variation of K_h is very small, namely, from .02 to .03 over a range of $\frac{L}{B}$, which embodies nearly every type and size of cargo vessel, and this small variation renders K_h most accurate for preliminary work.

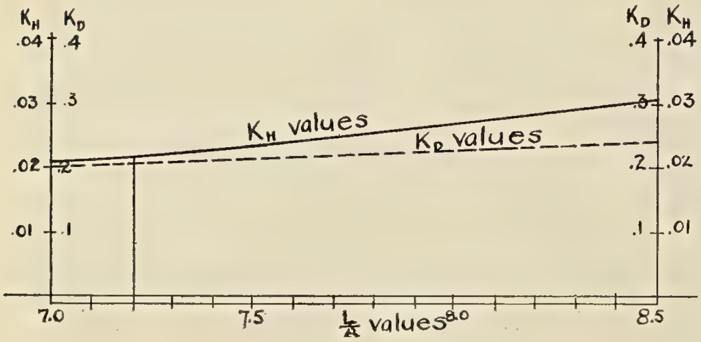


Fig. 1

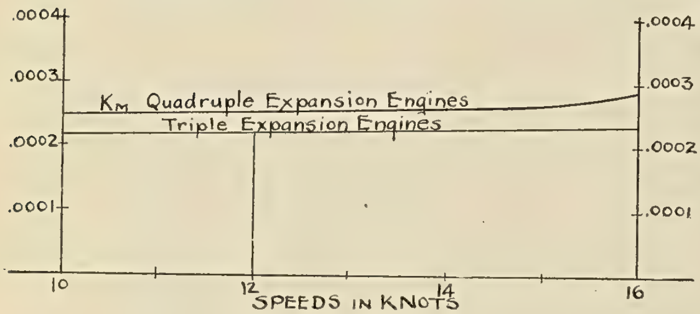


Fig. 2

In regard to the machinery weight, this is usually expressed as a coefficient of the horsepower of the ship.

Weight of machinery $= C_m \times I.\,H.\,P.$, and for our particular purpose the right-hand side of the equation has to be expressed in terms of the linear dimensions.

$$I.\,H.\,P. = \frac{(\text{Displacement})^{2/3}\,(\text{Speed})^3}{\text{Constant}} = \frac{D^{2/3} \times V^3}{C}$$

$$I.\,H.\,P. = \frac{\left(\dfrac{L \times B \times d \times b}{35}\right)^{2/3} V^3}{C} = \frac{(L \times B)^{2/3} \times d^{2/3} \times b^{2/3} \times V^3}{(35)^{2/3}\,C}$$

$$I.\,H.\,P. = K_m \times B^{4/3} \times d^{2/3} \times b^{2/3} \times V^3 \qquad (2)$$

where d = draft, b = block coefficient and V = speed in knots. Now these last three items are always known initially, so that the numerical part of expression (2) other than K_m, is determined at once.

Fig. 2 shows K_m values on an abscissa of speeds ranging from 10 to 16 knots. The values are divided into two classes, one for quadruple expansion and the other for triple expansion engines. It will be borne in mind, of course, that the curves here plotted are empirical and the results of many ships may show divergence from them, but any such divergence is not likely to be of a grave nature, so that, as in the case of K_h values, they will be found to have a remarkably accurate application.

$$\text{Displacement itself} = \frac{L \times B \times d \times b}{35}$$

$$= d \times b \times K_d \times B^2 \qquad (3)$$

Values of K_d are given in Fig. 1 along with the K_h values. The resultant equation for dimensions then becomes:

$$K_h \times B^3 + d^{2/3} \times b^{2/3} \times V^3 \times K_m \times B^{4/3} + \text{Deadweight} = d \times b \times K_d \times B^2 \qquad (4)$$

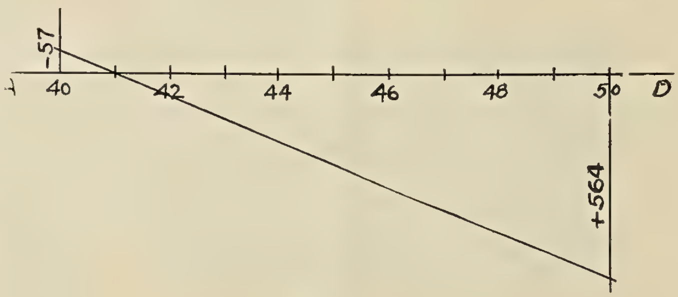


Fig. 3

Table I gives a sample catalogue of d, b and V values with their corresponding power values employed in the above equation.

Now, although equation (4) appears lengthy and complicated, such an expression only arises from the general way in which it is expressed. Every value in it except B is numerical, and B itself is determined in a simple graphical manner.

TABLE I

V	V^3	d^2	$d^{2/3}$	b	$b^{2/3}$
10	1,000	12 feet	5.24	.66	.759
10½	1,158	13 "	5.53	.67	.766
11	1,331	14 "	5.81	.68	.773
11½	1,521	15 "	6.08	.69	.780
12	1,728	16 "	6.34	.70	.787

A fully worked example will illustrate the procedure and application of the formulæ. A shipowner desires a new ship to carry a total deadweight of 2,000 tons at a speed of 12 knots on a load draft of 16 feet.

Assume first a block coefficient, say .69, and second a proportion of length to breadth, say 7.2; these, of course, requiring the judgment and experience of the designer.

Suppose also the vessel to have triple expansion engines.

Equation of dimensions:

$$K_h \times B^3 + d^{2/3} \times b^{2/3} \times V^3 \times K_m \times B^{4/3} + 2{,}000 = d \times b \times K_d \times B^2$$

From curves:

$$K_h = .0218,$$
$$K_m = .000225,$$
$$K_d = .204,$$

and from Table I:

$$d^{2/3} = 6.34,$$
$$b^{2/3} = .780,$$
$$V^3 = 1728.$$

Therefore the equation becomes:

$$.0218\,B^3 + (6.34 \times .78 \times 12^3 \times .000225)\,B^{4/3} + 2000 = 16 \times .69 \times .204\,B^2$$

$$.0218\,B^3 + 1.925\,B^{4/3} - 2.252\,B^2 = -\,2000.$$

Assume any figure for B, say 50, and substitute it in the equation.

The result is + 564.

Give any other value to B, say 40, and substitute again, when the result will be — 57.

It will be seen from this that B lies somewhere between 40 and 50 feet.

To determine B exactly, draw a line A-D and mark off

10 equal divisions on it. Call the first division 40 and the tenth division 50. Erect perpendiculars at these extremities as shown in Fig. 3, and mark off 57 and 564 units on opposite sides of *A-D*. Join the points so marked off and where the joining line cuts *A-D* is the appropriate value of *B*.

In the example, the appropriate breadth of vessel required is 41 feet and the length will be $7.2 \times 41 = 295$ feet.

If the vessel be of the flush, "three-deck" type, a suitable depth would be .73 times the beam = 30 feet.

The required dimensions then are: 295 feet $\times$ 41 feet $\times$ 30 feet to upper deck.

The trim, stability and capacities can now be verified and any slight discrepancy in the dimensions which these calculations may detect will, of course, be adjusted.

Double Cantilever Electric Traveling Gantry Crane, Installed in the Yards of the Union Iron Works, San Francisco, Cal.

Steel Storage in Shipyards

The convenient storage of the various classes of structural shapes and plates required for modern shipbuilding presents an unusual problem in efficient handling and transportation. In a large shipyard the storage must necessarily involve a large and constantly changing tonnage and cover a considerable area, and the material must be stocked in such a manner as to be readily accessible, this latter being a prime requisite.

The accompanying illustration shows a double cantilever electric traveling gantry crane located in the yards of the Union Iron Works Company at San Francisco, Cal. At the time the photograph was taken the "racks" were not all completed, but the general plan of storage is shown and it will be apparent that each classification is readily accessible and without disturbing other material. The storage yard is approximately 750 feet long and 175 feet wide, and is served both by railroad tracks and by the industrial tracks communicating with the adjoining fabricating shops.

This crane was built by the Shaw Electric Crane Company, of Muskegon, Mich. (Manning, Maxwell & Moore, Inc.). Its normal capacity is 3½ tons and the lift or hook travel 27 feet 6 inches. The span or distance from center to center of the rails is 33 feet. With a cantilever extension of 67 feet 6 inches on either side the overall length of the bridge amounts to 168 feet, giving an effective cross travel of the hook of 160 feet. The hoisting speed at full load is 60 feet per minute, the trolley speed at full load 300 feet per minute, and the bridge speed at full load 400 feet per minute.

The gantry structure is carried on eight wheels with four equalizing trucks, and the clear opening between the gantry legs is 30 feet, so that large plates can be handled without swiveling or interference. All three motions are controlled from the cage, located near the center of the trolley travel, where the operator has an unobstructed view of the entire storage. The plates are handled by grip-tongs and bundles of shapes by chain slings. It is reported that this crane effects a saving of eight men, but it is obvious that this statement is by no means the final measure of the economy, as the saving in time is probably fully as important a factor.

The Triple Screw Liner Statendam

The history of the Holland-America Line is a record of uninterrupted progress and development, and the launch of the triple screw passenger and mail steamer *Statendam*, which took place early in July, signalizes an even greater advance than anything previously recorded, the new vessel being nearly 770 feet in length overall, and over 86 feet beam, with a gross tonnage exceeding 33,000 and a displacement of 44,000 tons. The *Statendam* has been built to the highest class at Lloyds by Messrs. Harland & Wolff, Ltd., of Belfast, under survey of the British Board of Trade for passenger certificate and also to meet the requirements of the Dutch and American laws. The structure of the hull is exceedingly strong. The double bottom extends right fore and aft and there are eleven watertight bulkheads carried up to the bridge deck at the fore

part of the vessel and the saloon deck at the after part. There are 9 steel decks. The vessel has 3 funnels and 2 steel pole masts fore and aft schooner rigged, 4 derrick posts, 25 steel derricks, electric winches and Harland & Wolff steam steering gear, controlled by telemotor from the navigating bridge. A complete installation of electric light, also emergency lighting and wireless telegraphy and submarine signaling outfit, is also provided. The arrangements generally for working the ship and cargo will be of the most complete character.

The passenger accommodation provides for over 3,000 people, distributed into 800 first class, 630 second and nearly 2,000 third class. The first class passengers will be accommodated in one-berth, two-berth and three-berth rooms, the second class in two- and four-berth rooms. The first class public rooms include a dining saloon on the saloon deck, reading and writing room, lounge and palm court, smoke room and verandah, all on the upper promenade deck, and a gymnasium on the boat deck. The forward stairway has two passenger elevators serving six decks. The first class staterooms include thirty-two *en suite* rooms on the lower promenade deck, the other staterooms being arranged on the upper, saloon, bridge and lower promenade decks. Many of the first class staterooms are arranged on the tandem principle, securing natural light and ventilation to each. At the after end of the first class accommodation on the bridge deck a maids' and valets' dining room is arranged. The second class public rooms include dining saloon, smoke room and library, and the second class staterooms are arranged on the saloon, upper and middle decks. The third class passengers have a general room and smoke room on the saloon deck aft and a smoke room on the same deck forward. The third class messrooms are large, comfortable apartments on the middle deck. The third class sleeping accommodation includes a large number of permanent and portable rooms.

The captain's and officers' accommodation is in a deck house at the forward end of the boat deck. The engineers' are situated on the port side of the upper deck, convenient to the engine room. The chief steward's office will be placed at the main entrance of the bridge deck port side and the purser's office at the starboard side. The pantry and galley arrangements have been carefully devised to insure the best possible service. The vessel is provided with refrigerating machinery and refrigerated storerooms. The emergency lighting set, consisting of a Diesel engine and dynamo, is arranged in a steel house at the after end of the saloon deck with storage tanks on the bridge deck overhead. Boats are provided sufficient for all on board.

It will thus be seen that the *Statendam* will be complete in every respect, representing the highest attainments in naval architecture. In marine engineering also the vessel will embody the most recent advances, being, as already indicated, a triple screw steamer having a combination of the most highly perfected reciprocating engines with a low-pressure turbine.

Monthly Shipbuilding Returns.—Eighty vessels aggregating 21,477 gross tons built in the United States were officially numbered by the Bureau of Navigation, Department of Commerce, during the month of August. Steel steamships comprised 64 percent of this tonnage. In addition, two foreign-built steel steamships—the *Oceana*, of 7,796 gross tons, built at Dumbarton, and the *Moldegaard*, of 2,852 gross tons, built at Bergen, Norway—were admitted to the American registry under the Act of August 18.

The Cummings Engine Log System

Taking advantage of the uniform slip of propellers at any given speed of the vessel, Henry H. Cummings has developed instruments that automatically transfer the revolutions of the propellers into the distance traveled through the water. These instruments automatically compute accurately the distance traveled every hundred revolutions of the main engines and the revolutions per minute every two hundred revolutions of the main engines.

The system is operated by means of the vacuum in the condensers in such a way that connection between the condenser and the instruments is made every hundred revolutions of the main engines. An indicator pump, run from each propeller shaft, a direction indicator for each shaft, course counters and averaging counters, stop clocks and engine logs, together with connections, comprise the essential parts of the installation in full. The averaging counters give automatically and continuously the exact average of revolutions for the various propellers. To comply at the same time with naval requirements, which call for a continuous rotary counter, showing the total revolutions made by the engines, both ahead and astern, the connections to the averaging counter are provided with a "one-way gear," which runs the counter forward regardless of the direction of rotation of the shafts. It is claimed that the use of gears in the averaging instruments does away with the errors inseparable from other methods of driving these counters. In addition to the averaging counters, this instrument, which is in the engine room, carries a dial for the revolutions per minute, operated by means of a knurled handle at the left. By keeping the teeth in contact for thirty seconds by the watch the record of revolutions per minute is shown. If more accurate results are required, or it is desired to reduce the personal error in reading the watch, another gear may be thrown in and the reading taken for five minutes, giving the average revolutions per minute over that period. This device permits the engineers to check up the revolutions per minute, independently of the instruments on the bridge.

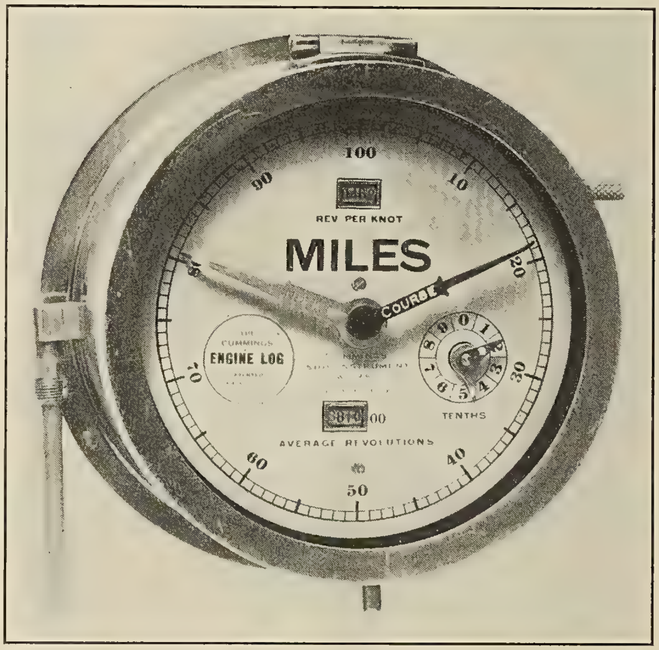


Fig. 1.—Engine Log

The direction indicators are operated by means of pressure or vacuum produced by a small pump connected to

each shaft. For rotation in one direction the vanes within the pump produce a partial vacuum, resulting in throwing the pointer into the "ahead" position. When the direction of rotation of the shaft is reversed, the vanes of the pump produce a definite pressure within the pipe leading to the indicator, thus throwing the pointer into the "astern" position. As soon as the shaft comes to rest the pointer returns to zero.

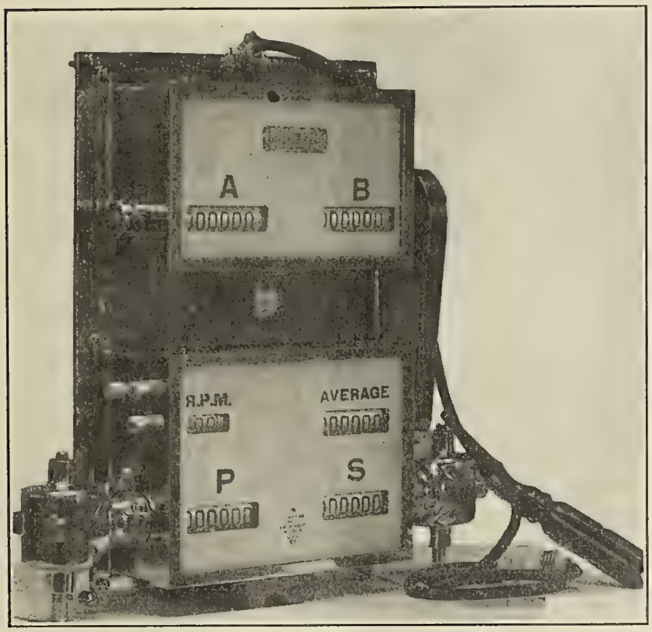


Fig. 2.—Two-Shaft Averaging Counter with "Course Counter" Above

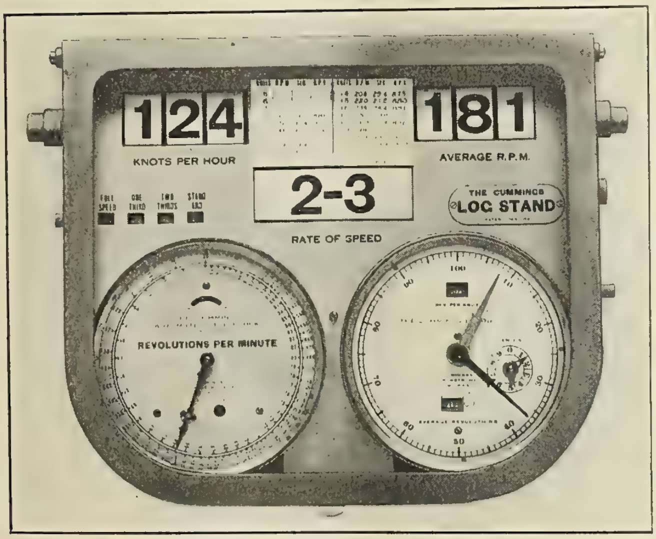


Fig. 4.—Log Stand for the Bridge

The mechanism of the stop clock is similar to that of an ordinary stop watch. The vacuum in the connecting pipe drops the piston, thereby starting the hand. The vacuum in the pipe is broken when the rotary valve shuts off the condenser connection, air then being admitted to the pipe and the piston returned by a spring. As soon as the engines make one hundred revolutions from the time of starting the clock, the pipe again opens to the condenser, the piston descends and stops the clock. The hand remains for several seconds at the point where it was stopped before being released and returned automatically to zero. The cycle is repeated every two hundred revolutions, one hundred being consumed in the motion of the hand and one hundred in its reading and recovery. An auxiliary dial around the circumference of the main dial on the stop clock is graduated in knots speed to fit each particular ship.

The counter in the engine log moves up one unit for every hundred revolutions of the engines, and two ciphers on the dial complete the reading. The log has a small opening at the top of the dial reading "revolution per

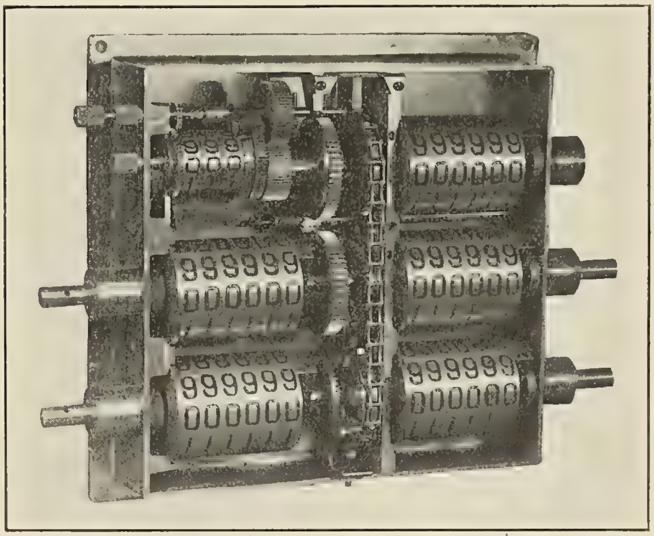


Fig. 3.—Mechanism of Four-Shaft Averaging Counter

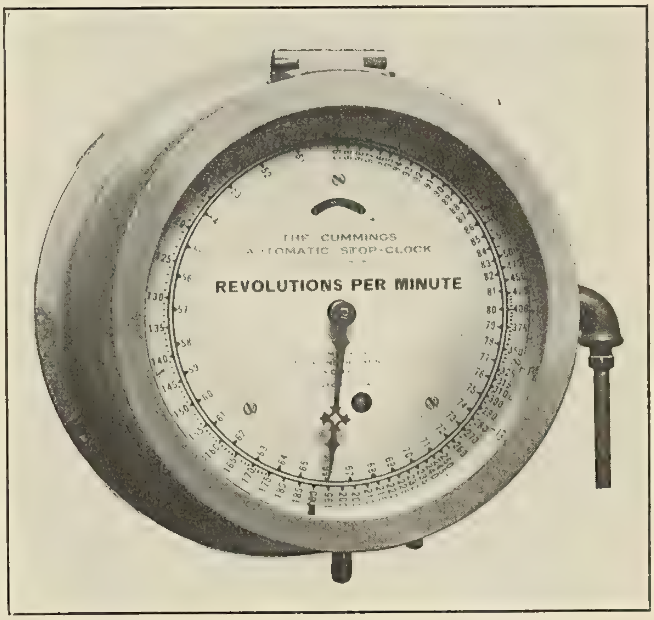


Fig. 5.—Stop Clock

knot," showing the revolutions required to make one nautical mile through the water at the desired speed. This figure may be changed, as the speed changes by means of a knurled knob on the right of the indicator. The engine log also has an auxiliary hand which is carried by friction upon the shaft of the main hand. This hand, which is labeled "course," may be set at zero upon passing a buoy or mark and will thus register the distance covered from any desired point. The accuracy of this instrument is, of course, dependent upon the navigator's ability to estimate the revolutions required per mile.

The auxiliary or course counter, above the averaging counters and usually in one engine room only, practically

completes the full installation. This counter, designed particularly for standardization of the propellers and for trial runs, contains two counting cylinders, and these are operated individually from the averaging counter below, one cylinder running while the other is stationary. This shows accurately the total "averaged" number of revolutions for a given time or over a given distance, and is operated or thrown in and out of action by an electrical circuit breaker from the bridge or any convenient place.

This apparatus is manufactured by the Cummings Ship Instrument Works, Boston, Mass.

A New Type of Internal Combustion Engine*

Two Two-Stroke Pistons Combined on Each Crank—Increased Power Developed for a Given Weight—Thirty Percent Overall Efficiency Obtained on Test

BY H. F. FULLAGAR, M.A.

Three fundamental factors are chiefly responsible for the difficulties in the construction of internal combustion engines of existing types; difficulties which increase with the size of the unit and ultimately limit the power which can commercially be built. These factors are:

(*a*) That the heat per unit of surface radiated by the flame to the cylinder walls increases with the size of the cylinder, while the thickness of metal through which this heat has to reach the cooling water also increases.

(*b*) That the weight per horsepower increases with the size of the cylinder.

(*c*) That useless forces are called into play; useless in that they are either stationary and do no work, or even produce negative work. These result from (1) the fluid pressure on the cylinder covers, which has to be transmitted through the framing of the engine; (2) the negative work of the compression stroke, which in single-acting engines produces a reversal of twist in the crankshaft; and (3) the inertia forces resulting from want of balance and imperfect cushioning.

The type of internal combustion engine described below eliminates all these factors, and has besides the advantages of mechanical simplicity and accessibility.

Description of System

The construction which is shown diagrammatically in Fig. 1 consists in using as a unit two open-ended cylinders side by side, each with two pistons, and rigidly connecting the pistons *A* to *D*, and *C* to *B*, by means of pairs of oblique rods, external to the cylinders.

The action of the engine is as follows: An explosion taking place between *A* and *B* drives *B* down and *A* up, drawing up *D* by the oblique rods, and giving, through the two connecting rods, two equal and opposite impulses to the two cranks. The side thrust produced by the oblique pull is, of course, taken by the crossheads of *A* and *D*, which are provided with suitable guides for the purpose. The obliquity of the rods is small, less than the maximum obliquity of the connecting rods, so that the friction is actually less than would be the case if each piston had its own crank and connecting rod, and the mechanical efficiency of the engine is high.

At the ends of their strokes, the pistons uncover inlet and exhaust ports in the cylinder walls, as in the Oechelhauser arrangement. The engine works on the "two-stroke cycle," and each crank receives, therefore, two impulses per revolution. Air is supplied to the cylinders by low-pressure air pumps, which can be driven from the engine by side levers in the ordinary way. In engines of the light high-speed types, for submarine and such purposes the upper crossheads and guides are formed to act as air pumps, and effect a further saving in space and weight.

Engines for stationary purposes will usually comprise two units, making four cylinders. For very large powers or when height is limited, as, for instance, in submarines, engines will comprise six or even eight cylinders.

It will at once be clear that with this construction useless forces are avoided or greatly reduced. There are no cylinder covers, or, in fact, any high-pressure joints in the engine. There are no vertical stresses on the framing of the engine at all. The pressure of the explosion is entirely taken between the steel parts, shown in Fig. 2, the crosshead, oblique rods, connecting rods and crankshaft; and only the secondary reactions of the slippers, from one-fifth to one-twentieth of the explosion forces, reach in a horizontal direction the framing of the engine.

The fluid pressure in each cylinder acts at every moment equally on the two cranks. The main bearings are thus relieved of practically all load, except for the weight of the parts, which, acting vertically, is just sufficient to keep the bearings in constant thrust.

The action of the explosion in driving apart the pistons *A* and *B* draws together, by means of the oblique rods, the pistons *C* and *D*, compressing the charge between them, so that the negative work of compression is performed, not through the crank and connecting rods, but directly through the oblique rods, and only the net useful work is transmitted to the crankshaft.

The reciprocating parts are cushioned at each end of every stroke, Fig. 3. This follows from the fact that each stroke includes a compression and explosion. On the upstroke, the pistons *A* and *D*, for instance, are cushioned by the pressure on *D*, and on the downstroke by the pressure on *A*. The combined effect of inertia and cushioning is to keep the oblique rods, except in the case of very small engines, in constant tension.

The effect of inertia is also to make the crank effort much more uniform. When an explosion occurs between, say, *A* and *B*, the force reaching the gudgeon pin of *B* is less than the explosive pressure on *B*, by the inertia of the connected pistons *B* and *C* with their crossheads and oblique rods, whose acceleration is at that moment at a maximum. The cost of an engine is largely determined by the maximum pressure to which its cranks are subjected, but it is the mean-effective-pressure which determines its useful output, and the nearer the maximum is to the mean, the lighter and cheaper the engine.

In single-acting engines, whether of the simple, tandem or Oechelhauser type, the explosion and compression strokes twist the crankshaft alternately in opposite directions, Fig. 4, producing a severe condition of stress, but, with the new construction, each connecting rod is double

* A paper read at the joint summer meeting of the Institution of Naval Architects, Institute of Engineers and Shipbuilders in Scotland, and Northeast Coast Institution of Engineers and Shipbuilders, at Newcastle-upon-Tyne, July, 1914.

acting, and the effort of each crank uniformly in one direction, Fig. 3. A four-crank engine, therefore, receives four pairs of balanced impulses per revolution, eight in all, so that the turning effort of this engine is unusually uniform.

Balance

The balance which results is practically perfect. The center of gravity of a pair of pistons, *A* and *D*, for instance, is at the point *P*, Fig. 2, and moves up and down on the line *PQ*, while the center of gravity of the other pair is at the point *Q* and moves down and up on the same line. This is probably the only engine in which the centers of gravity of the balancing masses have the same identical locus. Secondary inertia forces are produced by the angularity of the connecting rods, which causes the center of gravity of all four pistons to move up and down, by an amount which is shown in Fig. 5. The complete oscillation occurs twice per revolution, but in a four-cylinder engine with cranks at right angles the center of gravity of the second set of four pistons oscillates the same amount in opposite phase, so even these secondary vertical forces are completely eliminated.

Such then are the working forces in this mechanism. If they be divided into the two rough classes, which for the purpose of this brief description I have called "useful" and "useless" forces, the only ones falling into the latter class are the minor reactions from the slippers at the ends of the oblique rods, constant in direction and less, both in number and amount, than the "useless" reactions of any other reciprocating engine in common use, whether gas or steam.

Weight

As regards weight, the new construction, by combining eight two-stroke pistons with four cranks, produces a given power upon one-half to one-third the weight required with other constructions. The mean-effective-pressure with the two-stroke cycle need not be less than three-quarters of that with the four-stroke cycle. An engine of the new type is therefore equivalent to a four-stroke engine with not less than twelve pistons of the same size. Since larger cylinders are heavier for their power than smaller ones, a four-stroke engine of the same power with fewer cylinders of larger dimensions will be still heavier. Clearly, therefore, the saving in weight of the new construction is very considerable.

From a heat point of view, the double type of cylinder has incomparable advantages over all others, and with the new construction such cylinders require but one crank each. In form the cylinder is a plain tube, supported at either end, but free to expand axially, and surrounded with its fellows by a common tank, forming the water jacket. In such a cylinder, temperature stresses cannot occur. If a tube free to expand be heated symmetrically so that its temperature around each zone is uniform, variation of temperature along the axis of the tube produces no stress whatever. Moreover, in the absence of corners or pockets, the actual mean temperature of the inner surface of the cylinder is very low.

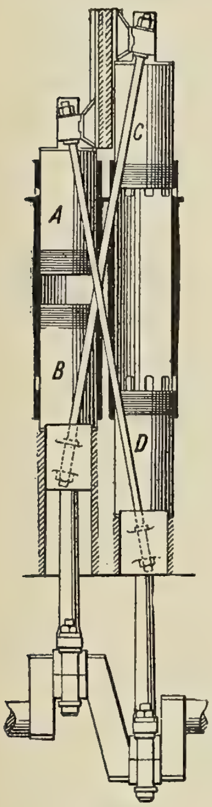


Fig. 1

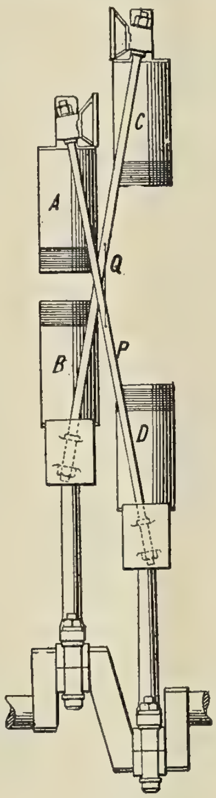


Fig. 2

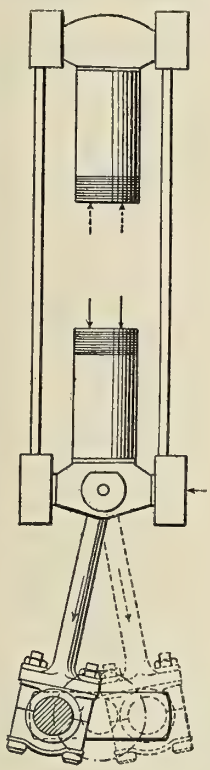


Fig. 3

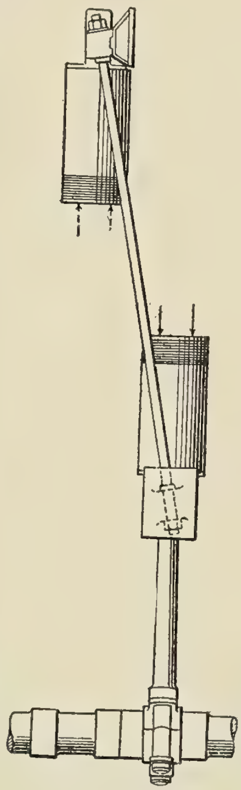


Fig. 4

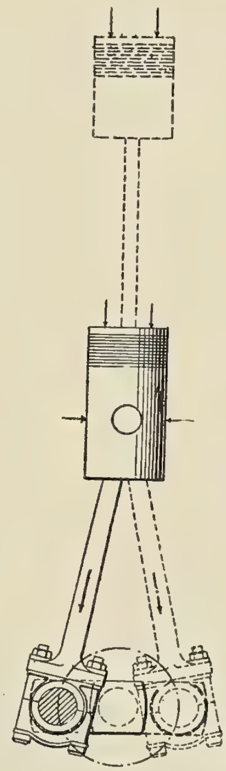


Fig. 5

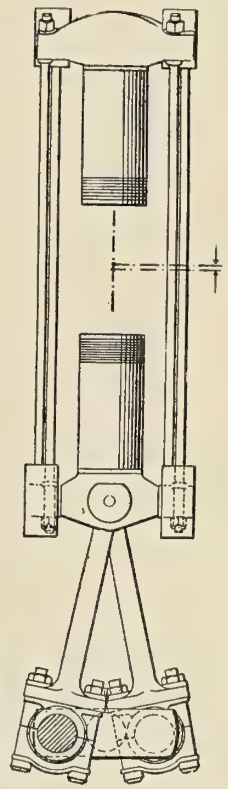


Fig. 6

Demonstration Engine

To test the system on a practical scale, an engine of 500 horsepower was built by Messrs. W. H. Allen, Son & Company, Ltd., of Bedford, to the designs of this company, and installed in the engine room of the Newcastle Electric Supply Company, at Gateshead. The power of the engine is absorbed by an electric generator connected with the Electric Supply Company's mains. The engine, which is of the stationary type and of substantial proportions, weighs without flywheel under 20 tons. It gives continuously some 550 brake horsepower, and its weight is therefore less than half that of gas engines of equal power.

This result is obtained with four cylinders only 12 inches in diameter, with the moderate piston speed of 750 feet

per minute, with the low mean-effective-pressure of under 70 pounds per square inch, a maximum stress in the steel parts of only four tons per square inch, and a stress in the cast iron portions of the engine nowhere exceeding three-quarters of a ton. The engine, in fact, produces its power upon half the usual weight of material, and with working stresses which, so far from being severe, are in the main appreciably less than exist in reciprocating steam engines.

The normal speed of the engine is 250 revolutions per minute, and even if this is increased to 300 revolutions per minute, the engine is still remarkably free from vibration. The crankshaft normally receives 2,000 separate impulses per minute.

An upper piston can be withdrawn in about ten minutes after stopping the engine, and the lower piston lifted out through the cylinder in five minutes more. The whole of the eight pistons can be withdrawn in an hour, with the use of a hand crane only.

This particular engine is supplied with air and gas by auxiliaries of a somewhat makeshift character, the air by a fan and the gas by a pump. In spite of this, the overall efficiency during a 30-hours' test from heat of gas supplied to brake horsepower was found by Professor Hopkinson to be just under 30 percent, while the indicated efficiency was 37.6 percent, the difference being largely accounted for by the inefficient auxiliaries. The mechanical efficiency of the engine itself is about 90 percent.

Perhaps the chief interest of the system lies in the promise it holds out of much larger powers with fewer parts and lower stresses, applicable to sea-going vessels of all classes. With no inclination to tempt the future by endeavoring to prophesy, I may point out that with gas as fuel and a mean-effective-pressure of under 70 pounds per square inch, it is a matter of arithmetic that a four-cylinder engine to develop 2,400 brake horsepower would require cylinders only 24 inches diameter, and for a 5,000 brake horsepower only 36 inches diameter, while with liquid fuel and a mean-effective-pressure of 115 pounds a diameter of only 24 inches is sufficient for 4,000 brake horsepower.

Another St. Lawrence Collision.—The Black Diamond collier *Lingan* rammed and sank the Government steamship *Montmagny,* with a loss of fourteen lives, during a fog, twenty-six miles from Quebec, in the St. Lawrence River early in the morning of September 18. The *Montmagny* sank within three minutes after the collision, while the collier, although leaking badly, proceeded under her own steam to Quebec.

An Economical Fueling Lighter

In connection with the fleet of self-propelled coal-carrying barges, built recently for the Alabama & New Orleans Transportation Company, a description of which was published in our November, 1913, and August, 1914, issues, there was also built an unusual type of fuel barge for bunkering the steamships at New Orleans. The fueling barge is of the same general design as the coal barges, its dimensions being limited by the size of the Lake Borgne canal locks to a length of 240 feet, a beam of 32 feet and a maximum draft of 7 feet. The general designs


Fig. 1.—Self-Propelled Fuel Lighter of 1,000 Tons Capacity

for the fueling barge were made by John H. Bernhard, of New Orleans, while the working plans were made by the Great Lakes Engineering Works, Detroit, Mich

The barge has a capacity of 1,000 tons of coal, the cargo space being divided into ten hoppers which are self-trimming with gates at the bottom to give access for the coal to two steel conveyors, one running from the bow of the barge to amidships and the other running from the stern to amidships. The conveyors drop the coal on steel hopper conveyors, which raise it in the square leg amidships, shown in the photograph, Fig. 2.

The bucket conveyor raises the coal to a height of 43 feet, and then it is moved over a scale and dumped into an S-shaped trunk which pivots around one point so that the trunk can be lowered and raised to reach any point between the water level and a height of 63 feet. At a height of 43 feet the beam overreaches the side of the fueling lighter, a distance of 30 feet.

The coal movement in the trunk is held in check by means of a steel conveyor. No matter how low the point of delivery, the coal will pass through the trunk only at a predetermined speed, as it is held in check by a steel conveyor. The same steel conveyor also forces the coal through the trunk wherever it is raised to a point high enough so that coal will not be discharged by gravity.

The barge is propelled by three 80-horsepower fuel-oil engines, and, when fully loaded, has attained a speed of 9½ miles per hour. The propelling machinery, however, can be disconnected from the propeller shafts and used for operating the conveyors. As the power necessary to operate all of the conveyor machinery on the barge is

Fig. 2.—Fuel Lighter Preparing to Coal a Freight Steamer

less than 80 horsepower, it is only necessary to disconnect one of the propelling engines for this purpose, although either of the propelling engines can be connected through the clutches to the dynamo, which furnishes the power for the conveyor motors. All of the motors are operated from a platform on the square leg amidships in the barge.

Although the exact cost of coaling with this fuel barge has not been disclosed by the owners, it is nevertheless stated that, including the transfer of coal in the harbor of New Orleans for a distance of ten miles to the bunkers of steamships and trimming, the cost is less than 17 cents (0/8½) per ton, which is remarkably low, as it is necessary for the lighter to go 19 miles down stream to receive this coal. The bunkering of steamships in New Orleans harbor by other methods is seldom, if ever, less than 35 cents (1/5½) per ton.

The machinery for this barge was furnished by the Fairbanks, Morse Company, Chicago, Ill., the engineering department of which worked out the complete details for the coal handling machinery, as well as for the main engines.

New United States Destroyers.—Bids for the construction of the six new destroyers recently authorized by Congress were asked for on September 3. The vessels will be 310 feet long, 29 feet 10 inches beam and 9 feet 6 inches draft, with a displacement of 1,108 tons and a speed of 29 knots. Each will have four 4-inch rapid fire guns and four triple torpedo tubes.

The Mersey Bar Lightship Alarm

The Mersey Docks and Harbor Board has recently placed at the bar of the river the new lightship *Alarm*, which was built by Messrs. Hawthorne & Company, Ltd., of Leith, to the design and under the supervision of Commander Mace, R. N. R., marine superintendent of the Mersey Docks and Harbor Board, to a special class of Lloyds, and is of steel with specially heavy scantlings.

The leading dimensions are: Length between perpendiculars on the waterline, 104 feet; breadth, molded, 24 feet; depth, molded, 15 feet. There is a small ward room and accommodation for the master and mate aft, and two compartments forward for the crew. One of these is reserved for sleeping and the other for messing purposes. The vessel is subdivided by means of watertight bulkheads, and is designed so that she may float with any two of the compartments flooded.

Other adjuncts of the ship are: A large winch operated by compressed air from the same source as that used for the fog signals, an installation of the Marconi wireless telegraph apparatus and a submarine bell. The chief feature of the ship, however, is the illuminating apparatus, which differs in many ways from anything previously made. This has been designed and constructed by Messrs. Chance Bros. & Company, Ltd., of Birmingham, and is of the dioptric type, and claimed to be the largest yet fitted on any vessel of the kind.

The lighting mechanism is contained in a glazed lantern, 9 feet diameter, which is placed at the top of a built-up steel tower, 26 feet 6 inches high and 7 feet diameter, with internal spiral staircases. The candlepower of the beam given by the lamp, as determined by calculation, is 35,000.

As ships entering and leaving the Mersey pass very close to the vessel, arrangements have been made to diminish the glare of the beam—which might cause inconvenience to navigation—by using a mantle of a special size to reduce the intensity of the light. This mantle can be replaced by one of standard dimensions at any moment to give the full illuminating power when desired. The apparatus embraces several novel features, one of the most important of which is the arrangement of the pendulum. This contains the air and oil receiver for the incandescent burner, the air being supplied at a pressure of 65 pounds per square inch from one of the containers of the fog signal plant by means of a pipe carried up inside the tower, or alternately by means of a hand-operated pump inside the lantern. The incandescent burner carries a mantle 50 millimeters diameter.

The gimbal carriage and lantern have been designed to allow a movement of the pendulum of 45 degrees on either side of the vertical, this being the greatest movement which has ever been allowed in an apparatus of this kind.

The optical apparatus is of the "small third order" size, 375 millimeters focal distance, and gives a triple flashing characteristic. It comprises three panels of refracting and reflecting prisms, two of which subtend a horizontal angle of 99 degrees each, and the other panel 81 degrees, also a dioptric mirror of 81 degrees horizontal angle and 500 millimeters focal distance. The appliance gives three flashes in quick succession every 30 seconds, namely, a flash 0.58 second, eclipse 4.08 seconds, flash 0.58 second, eclipse 4.08 seconds, flash 0.58 second, and eclipse 20.10 seconds.

The lenses are supported by a steel cable carried by the gimball ball bearing, which itself is carried by means of the ball-bearing carriage, fitted with horizontal and vertical rollers, all with ball bearings. A further set of ball-bearing rollers is placed under the carriage so as to

prevent the possibility of the apparatus lifting. The top table of the carriage is provided with a gunmetal race wheel, which is actuated by means of a bevel pinion in connection with horizontal and vertical shafts driven by clockwork mechanism, the latter being operated by a falling weight and steel wire rope guided in vertical ways in the tower.

The clock is placed on the floor of the lantern. All the main shafts of the clockwork mechanism are provided with journal and double-thrust ball bearings, the barrel shaft being of chrome vanadium steel, and the clock winding gear so arranged that it can be operated inside the lantern or at the bottom of the tower. If necessary the apparatus can be rotated by hand from inside the lantern and from the deck.

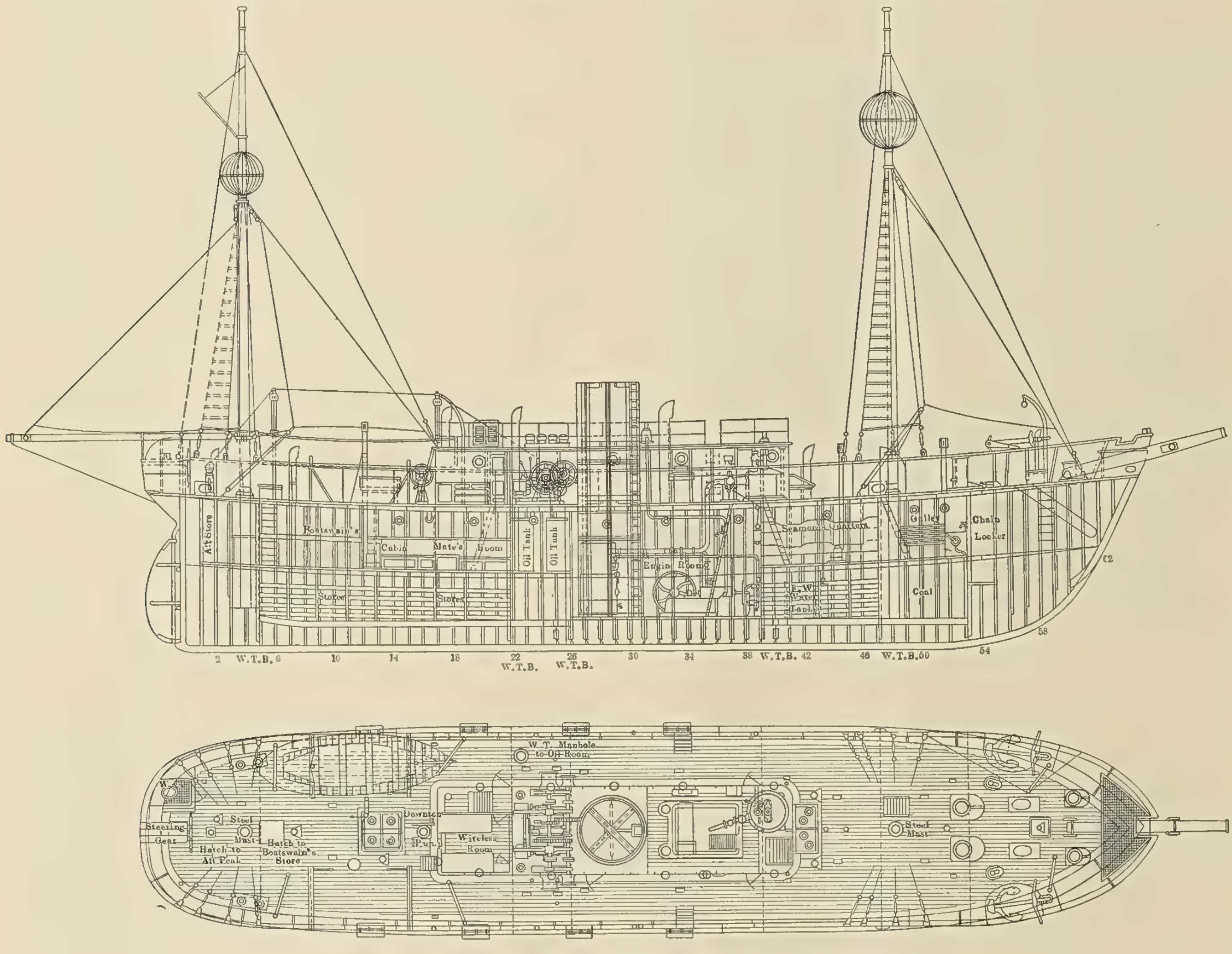
When not at work or when being cleaned the locking gear, consisting of three stays which fit into sockets on the pendulum casing, is used. One of these stays is adjustable in length by means of screw coupling. A further set of locking gear is provided between the top of the revolving carriage and the table which carries the lenses.

The lighting of the burner takes only a few minutes and can be performed by any unskilled man. The vaporizer is heated in a few minutes by means of a methylated spirit lamp in a well-known manner, and the oil is forced through the vaporizing tubes by the air pressure, when it issues as vapor and is ignited.

The fog signaling plant is designed to give a blast for two seconds during every 20 seconds. The compressing plant is in duplicate, each unit consisting of a double-acting, single-stage compressor, coupled direct to a Hornsby 11-brake-horsepower oil engine, and mounted upon a common base plate. Each unit alone is capable of maintaining sufficient air pressure to operate the signal, while one set is kept in reserve in case of breakdown. The engine and compressor cylinders are cooled by sea water, which is circulated by means of a pump driven off the crankshaft.

These compressors discharge into two air storage receivers of a total capacity of 200 cubic feet. These receivers are always charged to a pressure of 100 pounds per square inch, so that the signal may be sounded at a moment's notice and maintained for a space of about 15 minutes, which gives ample time to start up one of the engines. This is done by compressed air taken from the receivers, but as an alternative a small hand-operated air pump and receiver are provided. The air under pressure is led from the storage receiver to the sounding receiver in the deck-house through steel pipes of large diameter and easy bends, and the pressure at the siren is reduced by means of a valve to 25 pounds per square inch.

The siren is of the cylindrical pattern, giving a note of 182 vibrations per second, which corresponds with upper F sharp in the bass clef. In order to maintain uniformity of pitch, a friction governor is fitted to the siren. The siren and its admission valve are of the latest type, de-



Inboard Profile and Deck Plan of Mersey Bar Lightship *Alarm*

signed to give as far as practicable a free and uniform air flow. The admission of air to the siren is controlled by means of a small pilot valve, which is actuated by a weight-driven clock having a governor to maintain the regularity of the sounding periods. The trumpet is of the vertical type, of cast iron, and is provided with a mushroom head of copper. In order to guard against any possibility of failure of the signal, the air piping and valves are so arranged that either or both compressors may deliver into either or both receivers, while a permanent record of the time and duration of the blasts of the siren is obtained by an autograph recording instrument.

New French Liner for West India Service

Description of the Quadruple Screw Steamer Flandre, Recently Built at the Atlantic Works of the Ateliers et Chantiers of St. Nazaire

On May 21, this year, a new freight and passenger steamer *Flandre* left St. Nazaire, France, en route for Vera Cruz and other Central American ports on her maiden voyage across the Atlantic. This boat has been specially designed for service between France and West Indian ports. She was built by the well-known firm of Ateliers et Chantiers of St. Nazaire (Penhouet), at their Atlantic Works, to the order of the Générale Transatlantique Company. The main particulars of the boat are:

The *Flandre* leaving St. Nazaire on Her Maiden Voyage

Length overall	480 feet 4 inches
Length between perpendiculars	459 feet 4 inches
Beam	57 feet
Depth	37 feet 1 inch
Displacement at full load	11,330 tons
Speed	18 knots
Indicated horsepower	10,800

The hull of the vessel is divided into ten watertight compartments by transverse bulkheads; there is also a double bottom extending the full length of the ship, which is divided into twelve compartments, having a total capacity of 1,100 tons of water. There are in all seven decks designated as A, B, C, etc., decks, the F deck being the main deck.

One of the most interesting parts of the ship is the machinery. There are four screws, the two center screws being driven by reciprocating engines, and the two wing screws by low-pressure Parsons turbines. All of the large passenger vessels built in recent years at the Atlantic Works have this type of machinery. In fact, the first liner in which this arrangement was adopted was the steamship *Rochambeau,* built by this firm. The last one, which they have turned out prior to the *Flandre,* was the *Lutetia,* and, at the present time, two sister ships, the *Marsilla* and *Gallia,* are under construction at the Mediterranean works of this company, which will have the same type of machinery, except that on the *Gallia* there is only a single low-pressure turbine, whereas in the other ships each reciprocating engine exhausts into a separate low-pressure turbine.

The reciprocating engines on the *Flandre* have cylinders 33 inches and 47 inches diameter with a stroke of 36 inches designed to work at 115 revolutions per minute. The low-pressure turbines are 67 inches in diameter and

work at 420 revolutions per minute. The reciprocating engines develop 6,000 indicated horsepower, while the turbines develop only 4,800 horsepower. There are two condensers of the "Contraflo" type, making two independent steam plants in the ship.

Steam is supplied by six Scotch boilers, each 17 feet 9 inches diameter and 11 feet 6 inches long. There are in all twenty-four furnaces, the grate area amounting to 545 square feet and the total heating surface to 21,075 square feet. Designed for a working pressure of 200 pounds per square inch, the boilers are operated with Howden's system of forced draft and two funnels extending to a height of 100 feet above the grate bars.

Fig. 1.—Tank Schooner *Bearnais*, Fitted with Auxiliary Diesel Engine

All of the auxiliaries are of the latest type. The electric plant consists of three dynamos, electricity being used for lighting, ventilating and also for handling cargo and hoisting lifeboats. There are eight electric cargo winches and four electric lifeboat winches. The refrigerating plant has been specially designed for safe transportation of perishable goods.

The *Flandre* is fitted with a very complete outfit of appliances for navigating the ship, including a powerful wireless apparatus, twelve steel lifeboats, submarine signals, etc.

Accommodations are provided for 253 first class, 40 second class, 70 third class and 400 steerage passengers. On the awning deck is a large social hall for the first class passengers furnished in the period of Louis XVI. On this deck is also the first class smoking room finished in dark wood with leather upholstery. The rest of this deck is taken up with the staterooms de luxe for the first class passengers. Most of the first class staterooms, however, are on the promenade deck, the rooms having either one or two berths. Forward on the promenade deck are the doctor's and purser's staterooms, while aft is a children's play room. At the extreme after end of this deck is the second class smoking room and the main entrance to the second class accommodations.

On the deck below are the first and second class dining rooms, together with other first class staterooms. The main deck is given over principally to the second class passengers, while the third class passengers are berthed aft on this deck. Forward are the accommodations for the steerage passengers. The engineers, firemen and oilers are berthed on the main deck amidships in way of the boiler and engine rooms.

On her official trials, the *Flandre* attained a speed of over 19 knots, and it is expected that an average speed of 18.5 knots will be maintained in service.

Steamboats on the Ohio River Laid Off.—On account of lack of business, and also owing to the holding up of river and harbor appropriations, many of the boats on the Ohio River have been placed out of commission and their crews laid off.

United States Revenue Cutter Stranded on Reef.—The United States revenue cutter *Tahoma* struck a jagged reef and was stranded ninety miles to the westward of Kisha Island, off the far western Aleutian Islands, on September 20.

Mallory Liner Burned at Repair Yard.—The passenger steamer *Nueces*, of the Mallory Line, was burned almost to the water's edge on the night of Sept. 18, while lying at the Tietjen & Lang repair yard in Hoboken, N. J.

Launch of the Gulfstream.—The new tank steamer *Gulfstream*, of the Gulf Oil Company, New York, was launched at the yards of the New York Shipbuilding Company, Camden, N. J., September 17.

A Diesel-Engined Tank Schooner

Description of Dutch Tank Schooner of 425 Tons Deadweight Capacity Fitted with 120 Horsepower Polar Diesel Motor

BY F. MULLER VAN BRAKEL

The tank schooner *Bearnais,* illustrated in Figs. 1 and 2, was built by Messrs. E. J. Smit & Son, of Hoogezand, Holland, for Messrs. J. F. Humaran & Company, coal tar distillers at Bordeaux, France, and will be used for the transport of raw materials and products to and from the owners' distilling works near Blaye. As the freight will be shipped either wholly in barrels, or partly in barrels and partly in bulk, oil tanks for carrying oil in bulk as well as an ordinary cargo hold are provided. The oil space is divided into four separate tanks by means of a longitudinal and a transverse bulkhead, and is separated from the other parts of the ship by means of the customary cofferdams. Each tank has an oiltight hatchway large enough to permit the passage of oil barrels when an all-barrel freight is shipped.

The principal dimensions of the ship are:

Length between perpendiculars.................125 feet
Beam, molded.........................25 feet 6 inches
Depth, molded.........................11 feet 6 inches
Draft.................................10 feet 4 inches
Displacement at this draft....................650 tons
Block coefficient..............................0.694
Coefficient of midship section.................0.92
Deadweight capacity...........................425 tons
Gross tonnage.................................302 tons
Net tonnage...................................149 tons
Net tonnage to French rules (cofferdams deducted) ....137 tons
Capacity for oil in bulk, exclusive of expansion trunks ....50,000 gallons

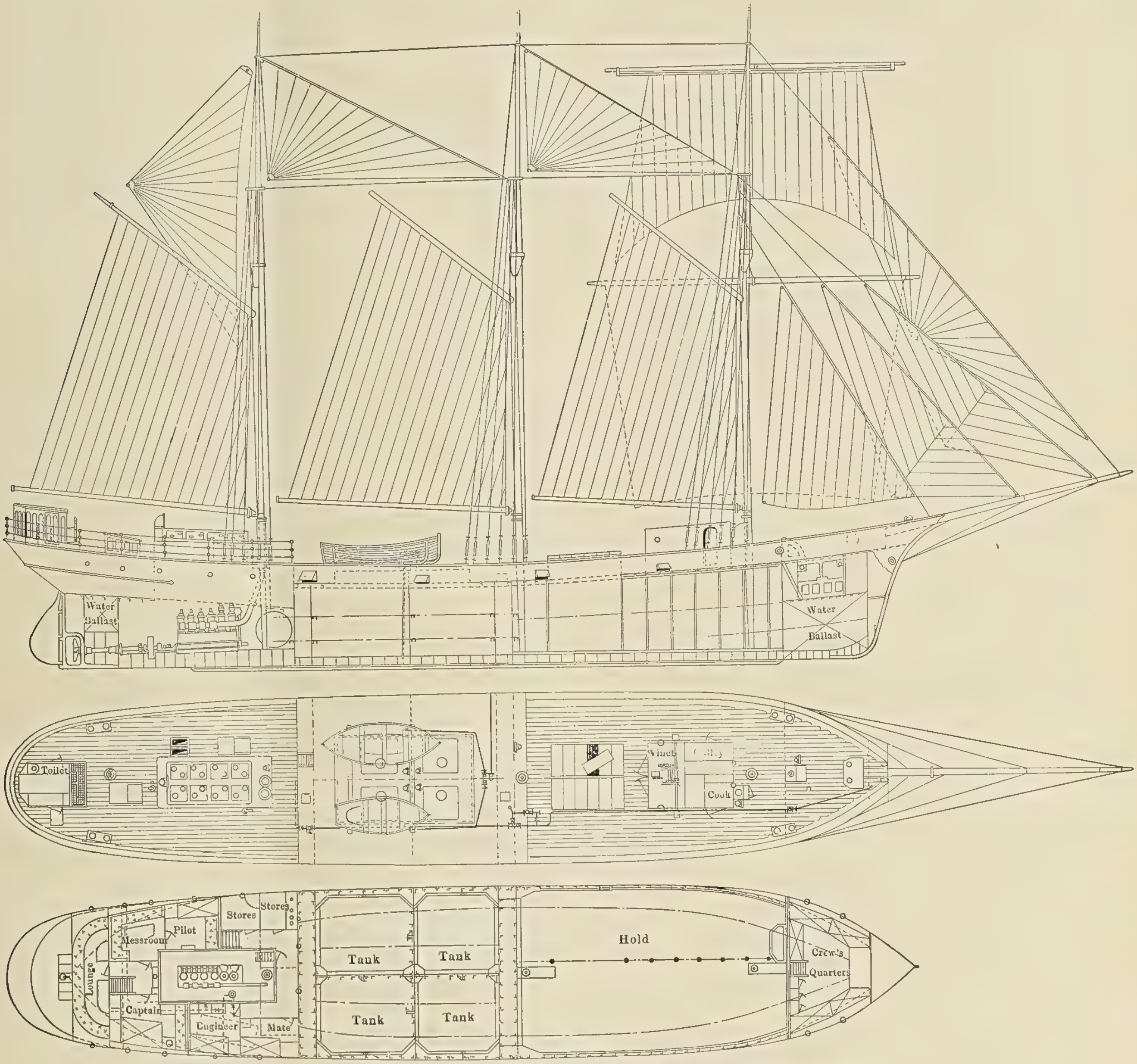


Fig. 2.—General Arrangement and Sail Plan of Tank Schooner *Bearnais*

Capacity of cargo hold................10,600 cubic feet
Capacity of forward peak tank for water ballast..27 tons
Capacity of after peak tank for water ballast.....12 tons
Capacity of fuel tanks....................3,000 gallons
Effective horsepower..............................120
Rig.................................3 mast schooner
Class: Bureau Veritas ✠ I 3/3 A I. I.

As the ship is intended to make short trips between France, Scotland and Portugal, it is obvious that harbor dues will be an important item to the owners. Consequently they decided on oil engine power for three reasons: first, because by means of such arrangement the ship could profit as far as the measurement is concerned to the fullest extent of "steamship" propelling power allowances without impairing the deadweight carrying capacity by the heavier weight of boilers and steam engines; second, because the owners, being oil merchants, have easy access to oil and fuel; and third, to eliminate all towage expenses.

The structural arrangements present no novelties. That part of the ship which is taken up by oil tanks (some 33 feet) is constructed to the rules for ships carrying oil in bulk with bulkheads, web frames, additional side keelsons and stringers, oiltight riveting and expansion trunks.

The sunken poop deck situated over the engine room contains staterooms for the captain, mate, engineer and pilot, together with the messroom, lounge, two storerooms and a sail room. A small wooden deck house contains the hand steering apparatus, lamp room and toilet. A steel deck house placed on the upper deck just aft of the foremast is divided into two parts, the forward part containing the galley and cook's quarters, the other part being a winch room where a 2-ton electric winch is placed for working the ordinary cargo. The crew space is situated forward and accommodates five men.

The vessel is lighted by electricity and there is a powerful electric light for cargo working at night.

Machinery

The main engine is a two-cycle Polar Diesel motor of 120 effective horsepower, designed to run at a normal speed of 300 revolutions per minute. The four working cylinders are 11 inches diameter and 13 inches stroke. The pistons are provided with circular safety pieces of special cast iron screwed into the tops of the pistons to protect them from becoming overheated. If the cast iron safety pieces become overheated and crack, they may easily be replaced by spare pieces.

Besides the four working cylinders, there are two cylinders fitted with piston valves which are worked by compressed air for starting in the manner of an ordinary compound steam engine. As soon as the motor is started the air-admission valve is closed and the air-starting cylinders automatically become scavenging cylinders.

On the tops of the maneuvering cylinders are placed the high- and low-pressure compressors, of which one is a duplicate. Starting and reversing is almost instantaneous, the reversing from full power ahead to full power astern being accomplished in six seconds. The motor can be slowed down to 60 revolutions per minute.

Besides the main engine and three main fuel tanks, there are in the engine room a crude oil motor of 6 horsepower for driving the dynamo and the auxiliary compressor, two main compressed air reservoirs, one auxiliary compressed air reservoir, two auxiliary fuel tanks containing motor fuel and kerosene (paraffin) respectively—the kerosene (paraffin) being for starting the motor when cold—one auxiliary fuel tank for the 6 horsepower motor, two hand fuel pumps, etc. An engine telegraph, speaking tube and a compressed air whistle are placed within easy reach of the men at the wheel.

Convention of Atlantic Deeper Waterways Association.—The seventh annual convention of the Atlantic Deeper Waterways Association was held at the Hotel Majestic, New York, September 22, and on the Hudson River steamer *Berkshire* on September 23, 24, 25, 26 and 27. On the second day of the convention a tour of inspection was made of the waterfronts of Manhattan, Brooklyn and Jersey City. On the third day the delegates and guests of the association proceeded up the Hudson River on the steamer *Berkshire,* calling at West Point, Newburgh, Poughkeepsie, Kingston and Hudson. The fourth day was spent in Albany and the fifth day in Troy. At various sessions of the convention papers were read on The New York State Barge Canal, The Upper Hudson Improvement, The Atlantic Intracoastal Waterway Chain, Modern Barge Navigation, Steel Barge Construction, New York's Waterways, Local River Improvements and Progress in New England.

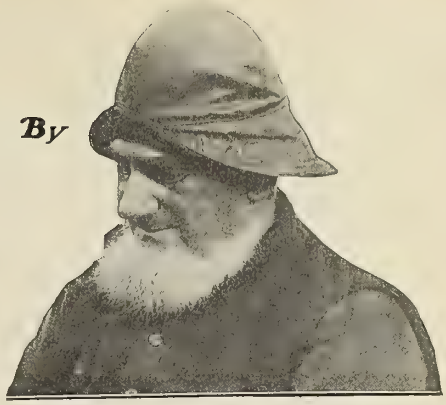
New Canadian Pacific Steamers.—Two new Canadian Pacific liners for transatlantic service are nearing completion at the yards of Messrs. Barclay, Curle & Company, Whiteinch. The first of these, the *Missanabie,* will leave Liverpool for Montreal October 7, and her sister ship, the *Metagama,* will soon follow her. These vessels are 520 feet long, 64 feet beam and 41 feet deep, with a gross tonnage of 13,000 tons. The displacement is 18,000 tons and the cargo capacity 400,000 cubic feet. Accommodations are provided for 520 cabin and 1,200 third class passengers, which, with a crew of 300, brings the total capacity up to over 2,000.

United States Battleship California.—The United States battleship *California,* authorized by Congress June 30, 1914, will be 624 feet long overall, 600 feet long on the waterline, 97 feet beam molded, 21 knots speed, and at a draft of about 30 feet will have a displacement of about 32,000 tons. The armament will consist of twelve 14-inch guns, twenty-two 5-inch rapid fire guns and four submerged torpedo tubes. The vessel will be propelled by turbines supplied with steam by oil-burning watertube boilers. The cost of the vessel, exclusive of armor and armament, will be about $7,800,000 (£1,600,000) and the total cost $14,920,000 (£3,060,000).

Loss of the Admiral Sampson.—On the morning of August 26 the Alaskan liner *Admiral Sampson* was sunk in Puget Sound with the loss of eleven lives, through a collision in dense fog with the fast Canadian Pacific passenger liner *Princess Victoria.* The *Princess Victoria* struck the *Admiral Sampson* on the port side abreast the after hatch, inflicting a wound which caused the American liner to sink in less than ten minutes. The damage to the *Princess Victoria* was such that sixteen bow plates will have to be renewed and a section of the stem replaced. The contract for this work has been awarded to Yarrows, Ltd., of Esquimalt, B. C.

Record Voyage to San Francisco.—The American-Hawaiian freight steamship *Pennsylvanian,* sixteen days out of New York, arrived in San Francisco September 17, having made the fastest voyage between the two ports ever made. The first vessel to reach New York from San Francisco via the Panama Canal was also an American-Hawaiian steamer, the *Nebraskan,* which completed her voyage September 6.

Economy Talks By "Old Scotch"



How to Tell When the Boilers are Properly Fired

Well, all you fellow horny-handed sons of toil, I am still going on with my remarks about combustion, as that's where the main part of this ten percent saving is coming from.

After all these rules about combustion and firing I've been telling you about, I guess you will want to know how you are going to tell when you are firing right. A fellow might think he is the real thing in almost any line, but it takes some impartial judge to tell him just where he gets on and off. Judgment is all right in its place, but instruments are better, as they can tell no lies. The real test of good firing is the amount of this CO_2 (carbon dioxide) that the gases contain just as they leave the boiler. That tells the tale of how the firing is done and whether too much air is leaking into and around the furnaces.

As this gas doesn't have any particular smell, it can't be expected that you can stick your nose into it and tell right away how much of that stuff is in the gases, so some people on shore have rigged up what they call a "gas analysis set." With this dingus you can read off the amount of CO_2 just as easy as you would measure out oil or water. It doesn't cost very much, and if you are going into this profit-sharing game you can afford to buy one, after you have made the necessary arrangements with the ship-owners.

Then, too, you will want to know the temperature of the gases going out of the boiler, as that gives you a line on what is being done inside. This is found out by using a special thermometer called a "pyrometer," and it doesn't cost very much, either. With these two instruments you can keep a very good line on what you are doing.

The low water mark on the CO_2 should be ten percent, and everything above that is so much the better to a certain extent. For instance, in some plants on shore where they have up-to-date managers they pay their firemen bonuses based on the amounts of CO_2 maintained. Ten percent is the minimum on which a bonus is paid, and compared with that the pay for 13 percent is four times as much. The mill owners find it pays them to give these bonuses, and the firemen are dead sure that it pays them to watch everything closely. If the CO_2 falls down from 10 percent, say to 5 percent, the fuel loss is about 25 percent, so it behooves you to keep it up to 10 percent or better if you want to save fuel.

The stack temperature does not indicate what is being done in the furnace so much as it does the efficiency of the boiler itself. As a general thing the temperature of the escaping gases at the bottom of the stack should not be much more than 100 degrees higher than the temperature of the steam which the boiler is making. Some stacks, if the fires are not properly handled, have been known to get so hot that they would set fire to the woodwork in their vicinity.

If all of the heat of combustion were applied to raising the temperature of the products of combustion, including the ash, the temperature over the fire in a furnace might run up to about 3,500 degrees F. Such a temperature, however, is never approached in the furnace of a boiler, for the combustion is a comparatively slow process and usually is not completed in the furnace. The flames extend over the bridge wall into the combustion chamber, and all the time there is an active radiation of heat from the burning fuel and gases and a rapid transfer of heat to the heating surface of the boiler. For this reason the temperature directly over the fire usually does not get much above 1,200 degrees F.

If the CO_2 falls down below the limit I have given you, you can be pretty sure that one of two things is happening, or perhaps both together. That is, your fires are too thin and allow the air to blow through them, or else there are bad air leaks around the boiler casings. In either case you want to remedy the evil just as quickly as the Lord will let you. If your fires have to be carried a little thicker and the next reading of your gas analysis shows the correct amount of CO_2, then mark the depth of your fires on your furnace fronts and try to carry them at this thickness afterward.

You must take great care to prevent air leaks, especially if you are using watertube boilers. In Scotch boilers there is not so much of a chance for air to leak into the furnaces except at the fronts, which you can control very readily. With boilers having casings it is different, as the air manages to leak in at all kinds of places. The only way to prevent it is to go nosing around the casings carrying a lighted candle. If there is an air leak the flame will be drawn into the crack or pinhole, or whatever it is. Some people may not like the idea of having hot candle grease dropped on their fingers or their knees, or whatever part is directly under the candle. If such be the case let them get a pine stick and dip the end of it in alcohol. This makes a fairly good torch without any drippings.

As soon as any leak is found, plug it up at once. Ordinary fire clay will do, but it may not last long. Therefore, mix it up with some asbestos fiber and it will do first rate to fill up large openings. Small leaks may be calked with asbestos rope and red lead. It doesn't matter so very much what you use as long as you stop the air from going into the furnace at all places except the right opening.

Next time I am going to discuss other matters about boilers, as I reckon you are tired of learning so much about combustion. You know, of course, that combustion is all about hot air, anyhow.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—What will be the pressure on the low-pressure crank, neglecting weight of parts, for a cylinder 72 inches in diameter with 10 pounds pressure in the receiver, and 26 inches vacuum? M. P.

A.—Neglecting also the effect of the valve and ports, there is a possible difference of pressure acting on the piston of $10 + 14.7 - 2 = 22.7$ pounds per square inch. On a piston 72 inches diameter this would give an effective force along the piston rod of

$$\frac{\pi \times (72)^2}{4} \times 22.7 = 4{,}072 \times 22.7 = 92{,}400 \text{ pounds}$$

which may be resolved into components along the connecting rod and perpendicular to the crosshead guide. With

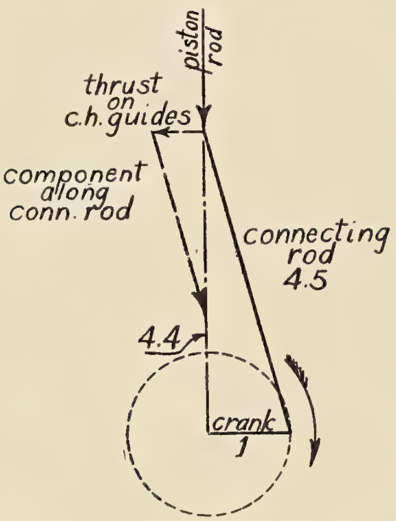


Diagram of Forces on Crank

the customary ratio of connecting rod to crank of 4½, we have, when the crank is at 90 degrees, the maximum force of

$$\frac{4.5}{4.4} \times 92{,}400 = 94{,}500$$

(See sketch.) This is the greatest pressure on the crankpin. It should be borne in mind that accepting the difference between the receiver and condenser pressures as the effective pressure is but a rough assumption, and is unsatisfactory for refined calculations. It, however, generally gives a value in excess of that obtained by the more correct method of taking the difference in pressure from the indicator diagrams and correcting for the effects of reciprocating parts and weights.

*Assistant Professor of Naval Achitecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

Q.—If I know the developed area of a propeller, can I find the projected area except from the drawings? L. T. T.

A.—Yes. Barnaby gives in his book on propellers.*

$$\text{Projected Area} = \frac{\text{Developed Area}}{\sqrt{1 + 0.425\left(\dfrac{\text{Pitch}}{\text{Dia.}}\right)^2}}$$

which gives a good approximation to the result desired.

Q.—As the difference in temperature of the steam entering and leaving a cylinder of a steam engine is increased, what source of waste is greatly increased, and how can this waste be partially avoided? ENGINEER.

A.—The condensation on the cylinder walls (frequently called initial condensation). This can be minimized by steam jacketing the cylinders.

Q.—How much more power will it take to drive a four-bladed propeller than a three-bladed one, if the dimensions are the same? A. L.

A.—From 23 to 30 percent more for the same revolutions, depending upon characteristics of form and operation. For detailed information on this subject see "Speed and Power of Ships," by D. W. Taylor.

Q.—How will I figure the amount of steam which a 3-inch pop-safety valve will discharge? MAC.

A.—The data necessary are steam pressure and quality, area of opening of seat and amount valve lifts; knowing these, the discharge can be figured approximately, using the thermodynamic formulæ for flow of steam through an orifice. The best information on this subject is contained in a paper to the American Society of Mechanical Engineers, by E. F. Miller,† in which are given the amounts *actually discharged* through 3-inch and 3½ inch valves of different styles, and under different conditions. The following table is compiled from this:

TABLE OF STEAM DISCHARGES OF CROSBY MUFFLED LOCOMOTIVE POP SAFETY VALVES (WITH ROUNDED SEAT EDGE) IN POUNDS OF STEAM PER HOUR.

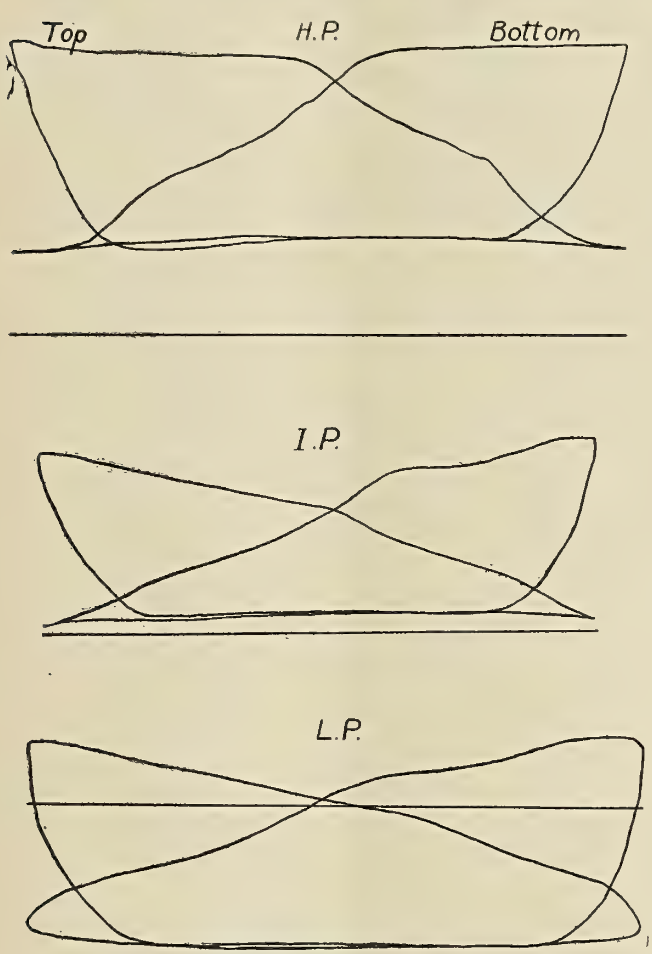
Valve Size.	Pressure By Gage, Lbs	Lifts (Inches)			
		.02	.05	.08	.10
2½...	160	1,819	4,380	6,599	8,078
	180	2,027	4,882	7,354	9,003
	185	2,080	5,007	7,543	9,235
	200	2,235	5,383	8,110	9,928
	205	2,288	5,508	8,299	10,159
3.....	160	2,217	5,354	8,033	9,809
	180	2,470	5,967	8,952	10,932
	185	2,534	6,120	9,182	11,213
	200	2,724	6,580	9,872	12,055
	205	2,788	6,733	10,102	12,336
3½...	160	2,647	6,326	9,437	11,361
	180	2,950	7,050	10,517	12,662
	185	3,026	7,231	10,787	12,987
	200	3,253	7,774	11,598	13,962
	205	3,329	7,955	11,868	14,288

Q.—Please calculate the horsepower from the inclosed cards taken from a twin-screw car ferry steamer equipped with engines having jet condensers, and air pumps attached to the intermediate crossheads, eccentrics keyed on, Stephenson link motion, piston valves on the high and intermediate and double-ported slide valve on the lows. These engines will develop much more power, but this is all that is required. We have made an effort to make each cylinder develop the same power. I notice the usual practice is a large increase of power in the intermediate over the high, and a large increase in the low over the intermediate. Is there any good reason for this? F. L. M.

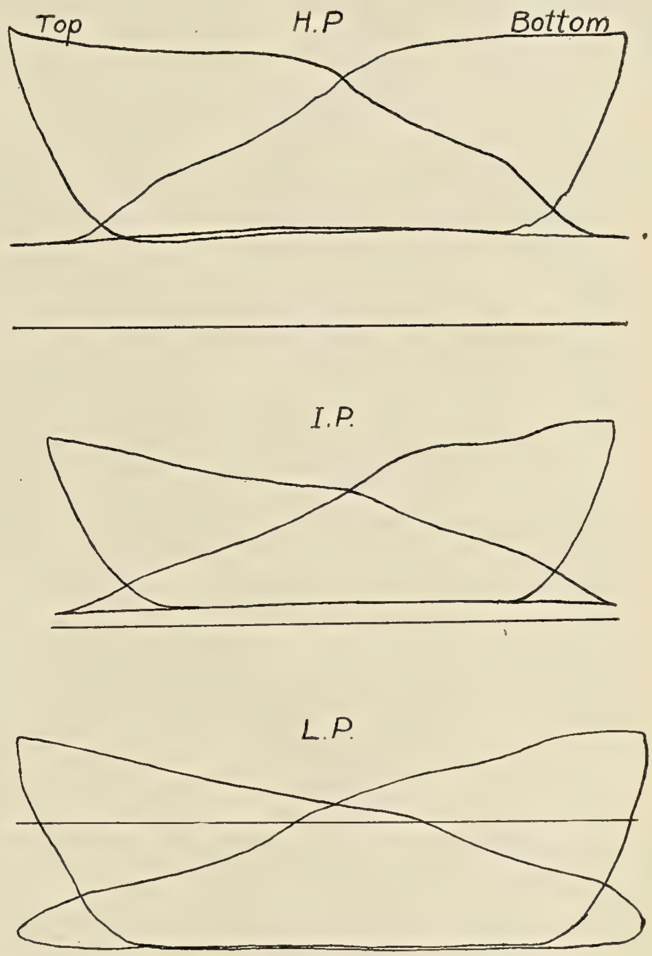
* Marine Propellers, by S. W. Barnaby.
† Results of tests on the discharge capacity of safety valves. 1910.

A.—The solution for indicated horsepower by means of the planimeter and assuming 4½-inch piston rods, is tabulated at the bottom of this page.

The low-pressure cards are excellent. The intermediate and high would be improved by working the gag screws for these cylinders to give a later cut-off and release. This would also improve the distribution of power, which should be equal for each cylinder. The greater power which is frequently found in the low-pressure cylinder is the result of poor design or to offset attached auxiliaries. It is well to test out the effect of small movements of the high-pressure gag screw upon both the high-pressure and intermediate-pressure cylinder by taking cards on these cylinders before and after changing, but without removing the cards from the indicators so as to get the cards showing the change superposed on the cards in the present condition. It is quite possible that the moving of the high-pressure gag alone will remedy the defects of both cards. In your case, as the air pumps are attached to the intermediate cylinder, it would be desirable to have that cylinder have an excess of power about equal to that required for the air pump. The droop in the back pressure lines of the high-pressure cylinder indicates a slight



Indicator Cards from Port Engine



Indicator Cards from Starboard Engine

CARDS OF TRIPLE EXPANSION ENGINE.

$\dfrac{19 \times 31 \times 53}{36''}$ at 92 R.P.M.

			Area Square Inches.	Length Inches.	Spring.	M. E. P.	Area of Piston.	I. H.P.	I. H.P. Per Cyl.	I.H.P. Total.
Starboard Engine	H.P.	Top	3.35	4.13	80	64.8	283.5	153.8		
	H.P.	Bottom	2.88	4.13	80	55.8	267.6*	125.1	278.9	
	Int. P.	Top	2.13	3.75	40	22.7	754.8	143.1		
	Int. P.	Bottom	2.07	3.75	40	22.1	738.9*	136.5	279.6	
	L.P.	Top	3.58	4.20	10	8.52	2124	151.1		
	L.P.	Bottom	3.45	4.20	10	8.24	2108*	145.6	296.7	855.2
Port Engine	H.P.	Top	3.37	4.11	80	65.5	283.5	155.2		
	H.P.	Bottom	3.03	4.11	80	59.4	267.6*	132.8	288.0	
	Int. P.	Top	2.20	3.78	40	23.3	754.8	147.0		
	Int. P.	Bottom	2.18	3.78	40	23.1	738.9*	142.8	289.8	
	L.P.	Top	3.47	4.12	10	8.44	2124	150.0		
	L.P.	Bottom	3.40	4.12	10	8.26	2108*	145.7	295.7	873.5
Total										1728.7

*Assuming piston rod = 4½ inches diameter and no tail rods.

throttling of the steam during exhaust, presumably caused by insufficient ports or excessive exhaust lap on the valve.

Q.—If the temperature of steam supplied to an engine is 331.161 degrees F., and the temperature of the exhaust is 219.452 degrees F., what is the thermal efficiency of the engine? D. O. S.

A.—The quotation of temperatures beyond the first decimal place is absurd for steam engineering work. The efficiency of the Rankine cycle (commonly called the thermal efficiency) between any temperatures is:

$$\text{Efficiency} = \frac{\text{Heat used}}{\text{Heat supplied}} = \frac{H_1 - H_2}{H_1 - h_2}$$

For this case the *heat used* is the heat contents of the steam at 331 degrees (H_1) less the heat contents of the steam exhausted at 219 degrees (H_2) after adiabatic expansion. The *heat supplied* is the heat contents of the steam at 331 degrees (H_1) less the heat contents of the condensed steam (which is the heat of the liquid) at 219 degrees (h_2). Assuming 8/10 percent moisture in the steam at admission, the solution using Peabody's Steam and Entropy Tables is:

$$\text{Efficiency} = \frac{1180.0 - 1047.1}{1180.0 - 187.4} = .134 \text{ or } 13.4 \text{ percent.}$$

Q.—I am on a freight steamer 471 feet by 57 feet beam by 27 feet draft. Is it possible, without having the lines, to figure how much weight is required to sink her 1 inch? If so, how is it done? L. D.

A.—It is impossible to figure accurately the tons per inch of immersion without the "lines."

$$\text{Tons per 1-inch immersion} = \frac{\text{Area Waterline Plane (square feet.)}}{12 \times 35}$$

If the boat is a freighter, she is probably full formed and one can estimate the area of the load waterline, say approximately 87 percent of the surrounding rectangle, whence

$$\frac{.87 \times 471 \times 57}{12 \times 35} = 55.6$$

would be the tons per inch of immersion at load draft. At lighter drafts it would be less, as the waterlines are finer. Load waterline coefficients vary from .8 to .9 (80 percent to 90 percent) for full ships of 350 feet and over.

Q.—How is the power determined for the large Diesel engines now coming into use on seagoing vessels? O. E.

A.—By using the indicator, as with steam engines, but using a special type of indicator suitable for withstanding the very high temperatures encountered. These engines before installation are usually indicated and also run direct-connected to an electric generator, from which the power delivered is measured. Knowing the generator losses, the brake horsepower is readily found. In service the engines are indicated but rarely, as derangements are noticeable in other ways. There is, however, no especial difficulty in taking diagrams except where the crosshead and connecting rod are housed-in and it is hard to get at the piston motion.

Steam Lighter America

The steam lighter *America,* said to be the largest of her type ever built on the Atlantic coast, has just been launched at South Portland, Me., and is now having her machinery installed at that place. The *America* is 190 feet long, 38 feet wide, has a depth of hold of 16 feet and a capacity of 1,600 tons of stone. She cost $70,000 (£14,400).

The *America* was built and is owned by Philip H. Doyen, a contractor of Portland, who will use her in the construction of breakwaters and for the transportation of heavy stone in connection with other contracts. For the handling of this unwieldy commodity she has been fitted with one of the biggest derrick masts ever stepped. It is of Oregon pine 114 feet long and 29 inches at the butt. The hoisting machinery is located forward and the propelling machinery aft.

While the *America* was being launched, she stuck on the ways, and for several weeks resisted all attempts at starting again. In accordance with a clause of her insurance policy covering builders' risks, the underwriters, Messrs. Norton, Hall and Webster of Portland, at length took charge of the operations and floated her successfully, the operation costing $3,000 (£615).

Inlets Disastrous to Seagoing Steamers

Probably no steamship line on the Atlantic coast conducts its business under more difficulties than the Atlantic City Transportation Company, which operates seagoing freight and passenger steamers between New York and Philadelphia and the famous beach resort. The reason for this is that Atlantic City is on Absecon Inlet, which has a depth of only 12 feet of water at low tide, and is practically impassable in rough weather.

The last mishap to a steamer of the line occurred on September 13, when the 927-ton steel steamer *Atlantic City,* the newest and largest of the fleet, went ashore in a gale while bound down from New York, with 31 passengers aboard. Attempts are now being made to float the ship, which was built only two years ago at Port Richmond, N. Y., and has withstood the hammering well.

On December 31, 1911, the iron steamer *Alpha* went ashore on the bar and was later thrown in high and dry on the beach, her position being a very difficult one for the wrecking company and the crews of the Atlantic City and Absecon life-saving stations, who floated her after several months. As it was, her cargo of freight, valued at $6,000 (£1,300), was lost. The *Alpha* is of 366 tons and was built at Philadelphia in 1881. She was formerly the *Conoho,* engaged in freighting on the Maine coast before being acquired by her present owners.

The iron steamer *Brazoria,* of the same fleet, was wrecked on the bar August 26, 1910, while bound to Atlantic City from Philadelphia. Before wreckers could get to work on her she broke in two, and, together with her cargo, the whole valued at over $30,000 (£6,150), became a total loss. The *Brazoria,* originally the *Meteor,* was built at Philadelphia in 1883, and registered 423 tons.

Damage to the Steamer City of Chicago.—The steamer *City of Chicago,* of the Graham & Morgan fleet on Lake Michigan, which was partially destroyed by fire at the mouth of the Chicago River early in the morning of September 1, is to be brought to Benton harbor and later, under her own steam, will probably go to Manitowoc, Wis., to have her superstructure rebuilt. When the fire broke out the vessel was brought to a position of safety in a heroic manner by her captain and her chief engineer, William F. Johnston, of St. Joseph, Mich., who stuck to his post in the engine room until the vessel had been driven into the breakwater at the entrance to the harbor and wedged fast, so that the passengers and crew, to the number of 120, were put safely ashore without the slightest injury to anyone. Only the after third of the vessel between decks and the cabins and staterooms above that portion of the vessel were damaged. The engine suffered no damage except the shakeup from running the steamer into the breakwater. The only damage to the steel hull was the buckling of half a dozen plates at the bow and the bending of the stem. It is probable that her entire superstructure above the main deck will be rebuilt and that the steamer will come out in the spring of 1915 better equipped than ever.

Letters from Practical Marine Engineers

A Department for the Readers' Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Is the Turbine a Steam Hog?

Many practical engineers have the idea that the steam *rushes* through a steam turbine and that a turbine is exceedingly more wasteful of steam than a reciprocating engine; indeed, it has been the dream of more than one inventor to harness that *wasted* steam—sort of box it up and keep it from escaping, so that it might in some way do more work. So prejudiced are some that they will not listen to talk of water rate or steam consumption per horsepower, and yet these very figures compared by proper units prove conclusively that turbines are operated with less steam consumption per horsepower than reciprocating steam engines of equal capacity.

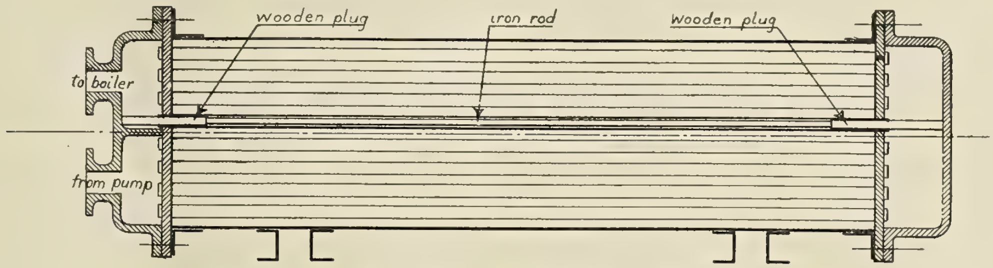
Probably the difficulty is for the engineer to understand that the elastic property of steam may be used in at least one other way besides that of expanding behind a piston, thus forcing it in or out on its stroke, as the case may be. It is understood that one pound of steam contains just as much energy as another pound of steam under the same conditions of pressure and temperature. This energy in the steam is heat energy, and must be changed into mechanical energy to do work. In the reciprocating steam engine the steam exerts a pressure on the piston and expands, losing heat; but in so doing it forces the piston in or out on its stroke and the piston moving alternately in and out transfers its motion through crank and connecting rod to the shaft where mechanical work is done. During this transformation of energy from one form to another a comparatively large amount of energy is lost through friction, radiation of heat, etc.

Now in the steam turbine the steam is expanded in a nozzle or its equivalent, giving up most of its heat energy but producing a very high velocity, with which it impinges on the blades of the drum or rotor, causing it to rotate, thus transforming the heat energy into mechanical energy also in the form of a rotating shaft. The losses in this transformation of energy are due to radiation, friction, etc.

Of course in both reciprocating engine and turbine energy is lost through the exhaust, but in both all loss is due to mechanical impossibilities, and therefore what applies to one on exhausting applies equally well to the other. It is easily seen that if theoretical perfection were possible, then the turbine and reciprocating engine would both develop the same power from the same amount of steam under the same conditions of pressure and temperature, because if theoretical perfection were attainable then there would be no losses, and if there were no losses all the energy in the steam would be converted into useful work.

By actual comparison these losses are found greater in the reciprocating engine than in the turbine, and therefore the turbine develops more power or creates more mechanical energy out of a pound of steam than a reciprocating engine. Therefore under the same conditions and comparing units of equal capacity for doing work, the steam consumption of the turbine per horsepower is less than that of the reciprocating engine, and this is due to mechanical or practical considerations only.

Brooklyn, N. Y. J. L. Wilson.



Section through Feed Water Heater Showing Location of Plug

Repairs to Feed Water Heater

Some years ago I had occasion to plug a feed water heater and had not enough time to remove both heads. It was a cast iron horizontal condenser type of heater about 8 feet long and containing about 60 tubes ¾ inch in diameter. The inlet and outlet nozzles for the feed pipe connections were on the forward head, so that removal of this head necessitated taking down the sections of pipe connecting with them.

No bypass had been provided and a split tube put the feed pump out of service, as the water leaked back to the exhaust steam space and thence to the condenser through the exhaust outlet. The injector would not take water from the hot well and we could not carry enough to make the run, and of course we would not use sea water unless unavoidable.

I had two hours before "leaving time" and I saw that it would not be possible to take down the sections of pipe and both heads and replace them in this time. So I took down the after head, located the split tube and made a white pine plug that I could just push through the tube. Then using a ½-inch iron rod I pushed the plug clear through until it took up against the forward head, as shown in the sketch. I then cut the rod off so that when the forward end was against the plug the after end was about three inches inside the after end of the tube. An-

other pine plug in the after end of the tube long enough to reach the rod completed the repair, and replacing the head I was ready to sail with a half hour to spare.

This proved thoroughly satisfactory and was run for several months before a permanent repair was made. Of course on our later installations of heaters we provided bypasses for both feed water and exhaust steam, and also made the pipe connections on a distance piece or neck between the head and tube sheet, so that the heads might be removed without disturbing any piping. Thus do we gain wisdom by experience. S.

Faulty Designing of Boilers

The writer believes that many boilers are designed without due regard to their efficiency and lasting qualities. All marine boilers are designed according to rules and regulations that have the force of law, but these rules and regulations only take note of the elements that enter into the question of safety, having no regard at all to the efficiency or upkeep of the boilers. The following experiences of such faulty design are a few of the many that have come under the writer's personal observation during a period of 25 years as a marine engineer.

A leg boiler was installed in a small tugboat and in a few weeks the side sheets in the furnaces commenced to bulge between the staybolts. The builders of the boiler were notified and they immediately stated, as a reason for this, that there was grease in the boiler. Examination of the boiler failed to discover any evidence of grease at all, but they persisted in the statement that it must be grease—that there could be no other cause for this bulging. The bulging became worse and the superintendent engineer decided to look for the cause himself. This boiler foamed considerably, particularly when the safety valve lifted while the engines were running. He inserted a gage cock in the outside of one of the legs and found that when the boiler foamed only dry steam came out of this gage cock when it was opened, showing that the foaming lifted the water entirely out of the legs.

The space between the sheets in the outside legs was only 4 inches and in the center leg only 6 inches. Evidently this was entirely inadequate to allow for the proper circulation of the water in the legs under certain conditions. A much better design would have allowed 6 inches between the sheets in the outside legs and 8 inches in the center leg. The difficulty was overcome to some degree by placing baffle plates under the steam opening, which partly stopped the foaming, but by the time this was done the side sheets were bulged so badly they had to be cut out and replaced with new material.

Another case of faulty design, and one that is too frequently found, occurred on a coastwise tugboat. The sheet in the back connection of the boiler began to bulge opposite and above the mouths of the furnaces. This sheet was stayed according to the rules and regulations, which provide that the stress on staybolts must not exceed 6,000 pounds to the square inch of section. The bolts were made large and spaced 7½ inches apart, leaving a large square unsupported except at the corners. It was suggested that extra stays be placed in the bulged parts of the sheet in the center of the squares. This was vigorously opposed by the builders of the boiler, who insisted that the boiler was properly designed and did not need any extra stays, although they could not—at least would not—give any reason for the bulging. However, the extra staybolts were put in and no further trouble has been experienced from this cause. In this case it would have been better to have used smaller bolts placed closer together.

An exactly similar case occurred on a large freight steamer in which the boilers were fitted with the Howden system of forced draft. In a very few months after being placed in commission the sheets in the back connections bulged as related in the former instance, and the trouble was remedied in the same manner, by placing extra bolts in the center of the square between the regular bolts. In both of these cases this was done before the sheets had bulged to any considerable extent. The writer is of the opinion that the space between the sheets and the back heads of these boilers was too narrow, particularly where forced draft was used. It stands to reason that when the hot fire strikes the sheet it forms steam rapidly, and unless there is ample room for the steam thus formed to get up and the water to flow down, the sheets will become dry and overheated.

In another case of boilers fitted with forced draft the two furnaces in one came down without any apparent reason. No oil was used in the cylinders of either main or auxiliary engines, and the boiler was as clean inside as the day it was built. The furnaces were pumped back in place, but in a short time came down again. There was no break in the rows of tubes in these boilers, being spaced about 4 inches apart horizontally, with about 12 inches space between the sides of the shell and the end row of tubes, and the bottom row of tubes was just 4½ inches above the top center line of the furnaces. The only reason that could be assigned for the coming down of these furnaces was that the fierce heat of the fires under forced draft changed the water into steam faster than it could flow down to the furnaces, and they became dry and overheated. New furnaces were installed and the bottom rows of tubes removed, being replaced with small stay rods to brace the tube sheet, and so far there has been no further trouble with these furnaces.

All marine engineers are conversant with the fact that a boiler built by one builder will steam considerably freer than a boiler of the same size built by another builder. The reason for this can only be in the design. A slight difference in the arrangement of the tubes in a boiler materially affects the circulation, and in that way affects the steaming qualities. A couple of inches difference in the distance from the top of the furnaces to the grate bars will make considerable difference in the combustion of fuel. In one instance that came to the writer's attention a boiler in a tugboat on her trial trip would hardly make steam enough to keep steerageway on the boat. The owner naturally refused to accept her, saying that he contracted for a *steam* boat, and she wasn't that by any means. At the suggestion of a practical marine engineer, who was on the trial trip as a guest, the grate bars were lowered 4 inches, and on the second trial trip the boiler furnished ample steam with the engines running wide open. This was a clearly demonstrated case of faulty design, although on the next boat that these builders turned out the same defect was found in the boilers and remedied in the same manner. It is rather curious how designers stick to their theoretical ideas in the face of practical demonstration of their faultiness.

Another defect in boiler design that is altogether too common is restricted steam space. In many boilers the area of water level and the steam space above the water level is so restricted that the release of globules of steam at each stroke of the engines carries water over into the engines with it, due to the fact that the area of water surface is insufficient to allow the steam to escape from it without violent disturbance of the water. It is rare, indeed, where the top row of tubes could not be dispensed with, thus increasing the steam space, and adding the heating surface thus done away with by lengthening the

boiler a foot or so, or slightly increasing the diameter, in many cases doing both.

The writer makes no claim to being an expert boiler designer, nor is this article written with the expectation that boiler designers will adopt any of the ideas suggested herein. Neither is he foolish enough to think that theory does not work out in practice, as so many practical men assert, but he does know that in many cases practice proves theory wrong, and these instances of experiences in practice prove the truth of this statement. J. S.

Boilers and Scale

Scale is the marine engineer's bugbear. More damage is done to boilers by scale than is usually realized. All engineers know what scale is, how it is formed, and the usual means taken to keep it at a minimum. The quantity and quality of the scale depend entirely upon the chemical composition of the feed water. The importance of scale has been brought home to engineers in the same proportion as the working pressures have increased in late years, owing to the higher temperatures. Water that has been made from steam in the condenser does not form any more scale, and so it is advantageous to prevent the loss of any of this water through steam leaking at pipe connections or stuffing boxes. All of this lost water has to be made up with fresh water from the reserve feed tanks. It is, of course, impossible to keep enough water in the boilers without using a little make-up feed each watch, but it should be the object of all careful engineers to keep the quantity of this make-up water as small as possible.

About a year ago I had the opportunity of inspecting the boilers on one of the largest oil carriers in the Pacific. These boilers had been giving us a great deal of trouble and had caused a great loss of time to the owners. The pressure system of oil fuel burning had recently been installed in the vessel with good results. It was found that on the run across the Pacific it was not necessary to stop in Japan for coal and the stays in port were reduced to the small number of hours required to discharge an oil cargo, but hereon hangs the tale.

The first trouble after installing the oil fuel burners was a leaky back tube plate. This was repaired in port by rebeading the tubes. The cause of this trouble was laid to the burners, insomuch as it was thought the long flame and high-pressure caused too great a temperature in the combustion chamber. The bridges in the furnaces were built up. This seemed to help matters, but didn't overcome the trouble. The next voyage the combustion chamber backs at the furnace level showed weepings about the stays, and it was decided to build up the back of the chamber with a good lining of fire brick up to the level of the furnace crowns. Upon the vessel's next arrival in San Francisco a newer type of burner was installed which, on a twelve-hour trial, showed still better results than the old ones.

With this type of burner it was considered desirable to take out the extra bricks in the combustion chambers and reduce the bridge to its normal proportions. On the boat's arrival in the East we received word that the backs of all combustion chambers were badly buckled and one had cracked between stays. This was at Hong Kong, a port well known for good boiler makers, and it was decided to make the necessary repairs at once.

The chamber backs were straightened and extra screw stays put in where it was thought they were needed. The crack was welded up by the acetylene process successfully. This was a pretty expensive job and we hoped would last until it was time for reboilering the vessel.

Upon reaching San Francisco after a run to Calcutta, the chamber backs were again in bad shape, the stays were leaking and all the nuts on the chamber tops were burnt off. The back tube plate was again leaking and we had another big boiler job on our hands. The ship's staff was convinced that all the trouble was due to the impinging flame and the high temperatures caused thereby.

At this time I made a thorough examination of the boilers. They had just been dried out, but as yet no work had been done. After a close inspection I decided that all our trouble had been due to an accumulation of scale. The tube ends and stay ends had large deposits on them. The chamber backs were covered with a half broken off coating of scale where the most severe buckling had been, although a lot of this had been removed in making the repairs in Hong Kong. The rear tube plate was also pretty well covered. At first I could not understand how this condition came about. The boilers were small and of a design not adapted to easy cleaning, but the scaling had always been done very satisfactorily by the Chinese scaling firms.

Upon investigation I found the causes to be two in number. The first was that, owing to the oil fuel, the hours in port were very much reduced, and therefore the scaling had to be done in a great hurry. Also, owing to the rush with which the overhauling on engines and boilers had to be done, the engine staff had been forced to neglect somewhat the inspection of boilers after scaling had been done. The second reason was that boiler scaling had very recently become the object of cut prices and keen competition among the Chinese firms. The low figures in vogue necessitated the hiring of smaller boys than usual, and fewer to a job. Scaling was done day and night, as a rule, with one going on all day and another at night, but under the present circumstances the same poor boys were doing a twenty-four-hour shift. Boiler scaling is never done better than is required by the engineer in charge, and when time is so limited and the chipping boys of such a young age, it is mighty hard to get a good job. The oil fuel boats also suffer because they do not have a large gang of firemen that can be sent into the boilers to chip.

The above incident is one of the many that have caused big boiler repair bills, and is offered as a suggestion to all engineers to be sure it is not scale before looking further. The vessel in question was retubed and the unfairness in all plates removed. Since then we have been getting good scaling jobs and have had no trouble to speak of.

F. K. R.

Salt Water in the Fireroom

My experience seems to show that the use of salt water in the firerooms, particularly in the ashpans and on the floor plates, is entirely too common. In many ships that I have been on, it seems to be the established custom to try to keep the material in the ashpans of watertube boilers in a wet condition at all times. I have tried to discover why this was done, but have only been able to get a vague answer that it saved the bottom of the ashpan from burning out.

A little reflection will convince even the most ardent advocate of this method that such a statement is entirely without foundation. In ordinary coal-burning boilers very little heat is radiated downward because the grate bars are partially in the way and there is usually a layer of more or less burning material just on top of the bars. If there is a good draft, practically no heat should get to the bottom of the ashpans by convection. As an additional safeguard, the ashpan usually has a considerable quantity of ashes covering its bottom. The temperature

of the ashpan bottom will never get to such a point that it is in danger of collapsing. All water poured into the ashpan is therefore not only useless, but quite undesirable as well.

The water, after evaporating, passes up with the draft of air, tends to cool the incandescent coal with which it comes in contact, absorbs a certain amount of heat, and then passes off with the gases of combustion. The only real thing the water has accomplished is to furnish a means for carrying a large number of British thermal units up the smokestack. In addition to this, it keeps the ashpan in a damp condition and aids corrosion.

From all that I can learn, this system of having wet ashpans at all times is a relic of the days when wooden hulls were in common usage. There might have been some logic in it then, as at that time it was possible to char or even to set fire to the vessel's timbers.

It seems to be the general custom to use salt water on the fireroom floor for three purposes; first, to wet down incandescent coal when hauling or cleaning fires; second, to dampen coal before firing; and third, to wash all the fine ashes and dust into the bilges.

A certain quantity of water is necessary in the first case, since it seems almost impossible to do this work without quenching the live coals.

In the second case—that is, for wetting the coal before using—the use of water cannot be recommended unless the coal is very fine and dry. In such a case it may be possible to effect a greater saving by keeping the small particles of coal in the furnace, instead of letting them go up the smoke stack with the draft, than is lost through the heat required to evaporate the water and highly heat the water vapor. Contrary to much fireroom opinion that I have heard, the water does not assist the coal in burning in any way. It retards the burning of the coal in every case. The fuel must be dried before it can be burned, and to dry the coal requires heat—uselessly expended in nearly all such cases. The water which was added to the coal goes off as very highly heated water vapor, and carries with it just that amount of heat necessary to effect the transformation that it undergoes.

In the third case, that of washing everything into the bilges, the practice is extremely bad. The ashes and coal get into the strainers and stop up the drain lines, while the water lodges between the floor plates and the supporting angle irons and there causes rapid corrosion. An old broom will give much better results in the long run.

The writer has had a little experience with the use of water by the men on watch below. In this case a small blowout occurred (on a small tube boiler) at the junction of the auxiliary steam stop and the boiler drum. The blowout was not very bad, but it necessitated the immediate hauling of the fires. This work was particularly hot, as the fires were heavy and were burning brightly when the accident occurred. Of course the ever-present hose was brought into service to quench the live coals drawn out. Everything was done in a proper manner until the man behind the hose decided that it was absurd to haul all of those hot coals out into the fireroom when they could just as well be quenched on the grate. So he turned the stream into the fire spaces of the boiler, where the cold water came in contact with quite a number of hot tubes. This man was almost immediately relieved of his particular job, otherwise the boiler would have been ruined.

It was remarkable to see what damage that little stream of water did in a few seconds. Several tubes split and many more were injured, but, fortunately, the pressure had been taken off the boiler by this time, so no serious accident occurred.

The repairs to this boiler took the ship's force several days. I believe, in all, about forty tubes were either cut out or plugged. It was a continual process of plugging all leaky tubes, putting on the hydrostatic pressure, having one or two more tubes split, then repeating the whole process. In the end the boiler was made tight and put into service once more, but I imagine that there must be some weak tubes in that part of the boiler even to-day.

It is on account of having had a few such experiences myself, and having heard of countless others of a similar nature, that I am led to the conclusion that all engineers would do well to keep the consumption of salt water in the firerooms at its lowest practicable limit.

W. W. B.

Burning of the Lumber Steamer Montana.—The wooden lumber steamer *Montana,* owned by George A. Kotcher, of Detroit, Mich., an old-time vessel built in 1872, with a carrying capacity of about one million feet, commanded by Captain George C. Burns, was destroyed by fire in Lake Huron off Alpena, Mich., September 7. Her loss will add something to the difficulties that owners of wooden vessels find in obtaining fire insurance on their ships. Many wooden vessels have been put out of commission on the Lakes through inability to obtain insurance, and a number of vessel owners have formed insurance pools to carry their own risks. The crew of the *Montana* returned to Detroit, although their personal belongings were lost on account of the rapid spread of the fire.

Crude Oil in Peru.—Most of the crude oil of the Lobitos-Negritos fields in Peru, which are controlled by the Standard Oil Company, is shipped to California to be refined and later returned to supply the markets of Peru, Bolivia and Chili with petroleum fuel. About 50,000 tons are annually returned to Peru, the larger part of which is used by the oil-burning steamers of the Peruvian Steamship Company. At both Callao and Paita are large storage tanks equipped with modern facilities for rapidly handling the oil. A fleet of tank steamers is employed in transporting the products of the Lobotis fields, the registered production of which amounted to over 331,000 tons in the seven years prior to last year.

New Southern Pacific Ferryboat.—The ferryboat *Alameda,* built in the Southern Pacific Company's shipyard at Oakland, Cal., was recently placed in commission by the Southern Pacific Railroad Company between San Francisco and Oakland Pier. The *Alameda* is a steel vessel 292 feet 4 inches long, 75 feet 4 inches beam over guards and 15 feet 3 inches deep, propelled by side wheels driven by engines developing 2,500 horsepower, which give her a speed of 19 knots. Steam is supplied at a pressure of 200 pounds per square inch by four Babcock & Wilcox watertube boilers fitted for burning coal.

Navigation from New Orleans to St. Paul.—The first cargo boat of any kind to make a through trip from New Orleans, La., up the Mississippi River to the head of navigation at St. Paul, Minn., was the self-propelled barge No. 5 of the Alabama & New Orleans Transportation Company. The cost of operation of the barge was so low that freight was accepted on the initial trip at 75 percent of the rail rate to the same point.

Japanese Coal Shipped to the United States.—Japanese coal is finding a ready market in all the ports of the Orient. The demand has rapidly increased of late, having extended to the west coast of the United States. So far this year San Francisco has received $500,000 (£102,500) worth from Nagasaki.

Marine Articles in the Engineering Press

New Naval Vessels for France, Spain, Canada and Russia—Annual Meeting of the Japanese Institution of Naval Architects—Economy of Steam Consumption

Types of Modern Steam Colliers.—By Maxwell Ballard, A. M. I. N. A. Treating the subject from a structural standpoint, it is noted that the design of the ordinary collier of the present day is based on the constructive ideas of the previous generation and that the tendency of shipowners is to regard such existing types as final so far as design is concerned, and to devote all their attention to the perfecting of the details of equipment. An outline of the main conditions and requirements that should be embodied in a successful steam collier and an analysis of the advantages and disadvantages of existing types as to the requirements outlined form a good comparative study. The results are rather discouraging, however, since no existing type is considered successful. The author then describes the Arch patent type of collier, which is the latest design offered to shipowners interested in the coal trades, and possesses considerable advantages over the ordinary types and the claims for improvements have been acknowledged as a result of actual experience. 1,600 words. 5 illustrations.—*The Shipbuilder,* July.

Lifeboats in Marine Disasters.—The recent clamor of the public and authorities for lifeboats on passenger ships equal to the full complement is in this article pronounced an exaggerated demand, which loses sight of more important considerations over one less valuable. Lessons are drawn from three marine disasters—of the *Elbe* in 1895, of the *Titanic* in 1912 and of the *Volturno* in 1913—to show that wireless telegraphy, combined with the most efficient watertight subdivision, would prove of far more value to save all passengers than even the very fullest boat equipment could do. It is given as the best consensus of nautical judgment that few more boats are needed on an efficiently subdivided and wirelessly equipped ship than there are boat crews available and able to handle them. It is considered that boats should fill only a temporary service, acting as ferries between the injured or burning ship and approaching relief ships or large drifting floats or rafts launched from the ship in addition to the boats with less difficulty and danger. Such life rafts, perhaps of the self-launching type, are considered the best auxiliary to an efficiently manned but limited fleet of lifeboats, which together would give enough time for an efficiently subdivided hull to keep afloat until the wireless calls bring relief ships to the spot. 7,060 words.—*Schiffbau,* June 10.

The French Destroyers Bisson and Renaudin.—A description of the torpedo boat destroyers *Bisson* and *Renaudin,* recently taken over by the French Admiralty, shows some interesting features. Both vessels are 256 feet 2 inches long between perpendiculars, 25 feet 8 inches beam, 16 feet 9 inches depth, with a draft aft of 9 feet 9 inches, giving a displacement of 715 tons. The hull in each case is of Siemens-Martin steel, having a breaking strength of 38 tons per square inch with an elongation of 15 percent. With the exception of the stem, the hull is clincher riveted throughout. The keel is of teak, 10 inches by 5 inches in cross section. The armament consists of four 18-inch torpedo tubes arranged in pairs above the turbine rooms. There are also two 4-inch quick-firing guns, one forward and one aft, and four 2.5-inch guns at the sides. The shells are conveyed by electric hoists from the ammunition rooms, which are ventilated by electric fans. The main engines consist of two Brequet marine turbines, designed to run at 630 revolutions per minute and to develop 14,500 shaft horsepower with a steam pressure of 171 pounds in the steam chest. A special feature of the machinery is the application for the first time of a new invention of the makers of the turbine. This is the *Ejectair Brequet,* and was used for the first time on the *Renaudin.* It is a dry-air pump which it is said has no moving parts, and of which the simplicity, safety and stability made a considerable impression on the technical men who saw it work. The article includes a description of the éjectair as used with both surface and jet condensers, showing the principles involved in its operation. In the official trials the *Bisson* made 31.98 knots and the *Renaudin* 31.267 knots over the measured mile. 1,000 words. 3 illustrations.—*The Engineer,* June 5.

Methods of Securing Economy in Steam Consumption—Superheating and Improved Condensing Apparatus.—By Lieutenant Commander H. C. Dinger, U. S. N. A few brief remarks on superheating, together with comparative figures and calculations on efficiencies with and without superheating, show that there is an enormous gain in economy that may be secured by the use of superheat on marine boilers. Commenting in this way and on the difficulties that may be encountered, together with actual results in practice, the author of this article leaves little doubt as to the advisability of using superheat. In connection with the general features of superheaters the various types are described in detail, first with watertube boilers and then with Scotch boilers. The principles of operation and construction details are described for such boilers and superheaters as Babcock & Wilcox and Foster superheaters, Lovekin superheater boiler, with a list of advantages for the use of the Lovekin superheater on Scotch boilers. The subject of superheaters in express watertube boilers brings up questions of necessary economy on vessels of the destroyer class and the feasibility of the use of reaction turbines with superheat. The superheating in connection with the Yarrow boiler is extended to include an improvement in steam turbine installations for superheating exhaust or receiver steam. In Scotch boilers the usual system is fitted by putting U-tubes into the boiler tubes at the smoke-box end and connecting them to steam headers. This principle is carried out very successfully in the Schmidt fire-tube superheater as manufactured by the Locomotive Superheater Company, New York. Separately fired superheaters have been used to some extent, especially in Germany, but it would appear that these add greatly to the complication and no advantages are apparent to warrant their use. The same argument that held for the use of superheat holds for the use of a high vacuum, since in using superheat the initial working temperature is increased and in using a high vacuum the final temperature is decreased. Further, there seems to be no excuse for using a vacuum as low as 27 or 28 inches, when careful operation will give 29 inches, with a considerable gain in economy. Probably the most important consideration for careful operation is air leakage and its elimination. The author explains this thoroughly and takes up the subjects of air treatment, baffling kinetic effect, relative location of condenser and air pump, circulating water and condensing surface re-

quired. In connection with the last-named sub-topic a table is given on some recent results for the amount of water condensed per hour per square foot of cooling surface at temperatures of circulating water and inches of vacuum obtained. After discussing the type of drive for circulating pumps the different types of condensers are described. Such types as the Westinghouse marine-service condensers with a Leblanc air pump and the Spiroflo surface condenser present many interesting features. Descriptions of the Hydroflo dry-air pump and the Weir dual air pump are then given and followed by various concluding remarks on other late installations, kinetic jets, most acceptable systems, position of condenser referred to engine, water agitating devices, cleanliness of cooling surface, protecting tubes from steam blast, testing condensers for leaks, corrosive action and a discussion on salt leaks. 18 illustrations. 17,000 words.—*Journal of the American Society of Naval Engineers,* May.

Recent Developments in Marine Propulsion.—Although in the form of an abstract of a lecture, delivered by Professor W. H. Watkinson at the Liverpool University, the article outlines the development of marine propulsion from the time of James Watt, and includes comparisons and actual statements of accomplishments in a clear and concise manner. No notable improvements have been made in boilers in recent years, and it is stated that the watertube type is taking the place of the Scotch boiler throughout naval work, but that the Scotch still remains in the merchant service. The greater possibilities of the internal combustion engine for marine propulsion necessitate considerable attention to this later development and much comment is made on its future, more from a standpoint of fuel than of its mechanical possibilities. 2,800 words.—*The Engineer,* August 7.

Limitations of the Submarine.—Granting that the submarine is a serious factor and one to be given a prominent place in any balancing of naval forces, and that the type will increase in size, power, speed and offensive capacity, it is doubtful that it will become a still more serious factor in the future. Its limitations in action are defined, and it is explained how these are imposed upon it by reason of the very qualities it possesses as an attacking force. The article argues clearly that the battleship is not doomed because of the submarine, due mainly to the limitations outlined of the latter, and that it is only a new method of attack that must be met with by other methods of defense and that provision of submarines must be ample to match those of possible foes. 1,900 words.—*The Engineer,* July 31.

Russian Naval Expansion.—The report that the Duma had just voted the expenditure of $48,000,000 (£10,000,000) for the construction of warships for the Black Sea fleet is confirmed and it is intimated that a second extraordinary expenditure will be involved in a second naval programme amounting to about $288,000,000 (£60,000,000). This does not include the sum of $131,500,000 (£27,400,000) provided for this financial year, but must be added to it. The author compares these figures with the outlay in previous years for the development of the Russian navy, and traces the attempts made for the reconstruction of the Baltic fleet particularly. In concluding, it is pointed out that the cost of constructing a battleship is declared to be double in Russia what it is in Germany or Great Britain, and that if such is true it is not surprising that English co-operation is secured in the development of the Russian navy, and that very large expenditures are involved in each naval programme which is submitted to the Duma for approval. 1,500 words.—*The Engineer,* June 19.

Foundations for Largest Ore-Shipping Dock in the World.—Foundations for the fifth and latest ore-shipping dock of the Duluth, Missabe & Northern Railway Company at Duluth, Minn., are 2,146½ feet long, 64 feet wide, and contain 24,225 cubic yards of concrete. The dock is the largest of its kind in the world and has a storage capacity sufficient to load fourteen vessels with an 8,000-ton cargo. On the inside of the dock the concrete capping the 14,600 round piles is 4½ feet thick, increasing by three 1-foot steps to the outside, where it is 7½ feet thick. U. S. steel interlocking sheet piles 40 feet long were driven 6 inches below low water around the entire dock between the two outer rows of round piles, to retain the sand pumped in from the bay to within 18 inches of the low-water mark. Steel columns for the dock rest on 395 concrete pedestals or piers 5 feet square on top and spaced on 12-foot centers. Two concrete handling plants were used, the first being mounted on double flange wheels running over rails 23 feet apart laid on 8 by 12 inch cross-ties 26 feet long, supported by capped piles. This track was removable, and as its support was under water relaying was accomplished by floating the section passed over around the plant to the piles ahead. Concreting was begun in August of last year and completed in November, and work on foundation started in February. 3 illustrations. 1,100 words.—*Engineering Record,* August 29.

Barge Canal Terminals.—By J. A. O'Connor. The improvements of the canal system of the State of New York by the construction of the Barge Canal raised the vital question of providing adequate terminal docks which would be controlled by the public. The design and construction of these docks have brought forth a number of interesting problems for the engineer, since in nearly every case construction must be carried on in or under water. Several types of docks have been designed to meet the conditions found at the various locations. At the site of the terminal dock at Albany an old timber bulkhead existed along the 1,500 feet of river front to be occupied by the proposed terminal dock. The bulkhead line as established by the United States Government extended only a few feet outside of the old dock, so that to construct a gravity wall would have necessitated expensive excavation of the old dock. A type of reinforced concrete sheet-pile bulkhead, with heavy concrete and steel ties anchored in concrete piles driven back of the old dock, was finally adopted. At the site of the Troy terminal an old timber dock must be removed to allow the construction of the new concrete wall about 960 feet long. The wall itself is of the standard gravity type, and it is proposed to construct a movable gangway at the north end of the dock as a means of unloading small boats. There will also be constructed a large storehouse at the northerly end which will have track connection with the adjacent railroad terminals. It is also proposed to provide freight-handling machinery which will transfer freight directly between freight cars and barges, as well as between barges and the freight house. In designing the dock wall of the terminal at Schenectady the nature of the foundation material encountered favored the construction of a concrete wall and slab resting on wooden piles. At Rome, where the foundation was gravelly, a sheet steel bulkhead was constructed, topped by a narrow concrete wall, and the entire bulkhead fastened with large steel tie rods, spaced 6 feet apart and anchored to a continuous line of wooden piles 40 feet back of the bulkhead. The plan for improving the harbor of Erie Basin, the western terminus of the Erie Canal, contemplates the removal of the southerly end of the breakwater and all

old piers, together with sunken wrecks, to provide a depth of water 23 feet in the basin. Two new piers and 300 feet of dock wall will be constructed by means of rock-filled timber cribs topped by a continuous concrete dock wall 8½ feet high. A portion of the dock wall lies wholly on land, and it was decided to construct this portion of sheet steel piling capped by a concrete wall 8 feet long by 12 inches thick, and to be tied back to a reinforced concrete anchorage. Several wrecks and a large amount of earth excavation have already been removed from this harbor. 5 illustrations. 2,200 words.—*Engineering Record,* August 29.

The Armament of the Spanish Battleship Espana.—The first of the new battleships for the new navy of Spain has just completed the trials of her gun mountings, and these have been entirely satisfactory both as to guns and mountings and to the ship's structure. The *Espana* is 435 feet long, 78 feet 9 inches beam and displaces 15,460 tons at a draft of 25 feet 6 inches. Both vessel and machinery were built at Ferrol Dockyard. The machinery is of the Parsons turbine type with Yarrow boilers. The vessel is designed for a speed of 19¼ knots at 15,300 shaft horsepower. The main armor belt is of 9-inch armor and the vulnerable parts of gun positions have 10-inch armor protection. There are eight 12-inch, twenty 4-inch, two 3-pounders, two 3-inch guns and two rifle-caliber Maxims. The 12-inch guns are mounted in pairs in barbettes, while the 4-inch guns are mounted in casements. The 3-pounders are semi-automatic quick-firing on upper deck mountings. The 12-inch capped projectiles penetrated 13.3 inches of K. C. plate at 10,000 meters range, while the 4-inch uncapped projectiles penetrated 4 inches at 3,000 meters. The gun trials were very satisfactory and the final test was a salvo of all guns on the port side of the ship, in which the firing was absolutely instantaneous, and a thorough examination afterwards showed not the slightest damage to the ship's structure, even though the guns were at maximum elevation to make it most severe. Besides a description of trials and results, the article includes detailed descriptions of the guns, together with mountings, breech and loading mechanisms, ammunition handling, etc. 8 illustrations. 4,250 words. —*Engineering,* July 31.

Japanese Institution of Naval Architects.—Of the various papers read at the meetings of this institution at Tokyo, three are given as abstract and one in full in this article. *The Salvage of the Umegoka Maru*: This ship was sunk in the Straits of Moji and lay on her port side on hard sand in 6 to 9 fathoms at mean tide. The operation involved getting the ship on an even keel and keeping her so while raising her bodily. In order to get the ship on a level keel, seven watertight sections were made between the shelter deck and boat deck, and these pumped clean to obtain buoyancy. A system of tripods was fitted to the starboard side, to the tops of which were attached a series of wire ropes and tackles, three in number, and anchored some 1,200 feet from the ship. The fulcrum for the system was obtained by two anchors on the opposite side of the ship. The falls from the tackles were led to the salvage steamer *Arima Maru* and to a large rock-breaker, which were equipped for hauling, and these vessels again were connected to the *Umegoka Maru.* After the vessel was turned over to a level keel in the upright position a 242-foot cofferdam was constructed and made watertight, and by carefully drawing from the different connections through the various pumps, the vessel was brought bodily to the surface on a level keel. *A Self-Recording Strain Meter*: The instrument described in this paper is an outcome of Mr. Stromeyer's arrangement made self-recording, and applicable to launching observations in the first instance, but also to any recording of stresses at sea, etc. The principle of operation of the instrument is to magnify by an increased leverage the compression or elongation between two points and to record this continually on a smoked paper drum revolving at uniform speed. The time and distance run by the ship are also recorded simultaneously. The increased leverage is obtained by means of two blocks capable of sliding by each other and having grooves cut in their faces, between which is inserted a knife-edged hard steel pin carrying an aluminum pointer with a light pen at its end. Various launching stress curves are given, showing how the results are plotted. *Ramsbottom Packing Rings*: This paper describes experiments on the distribution of pressure round the ring; when the inner circle is concentric with the outer; when it is eccentric; and when the rings are turned once only; when they are tightened after the first turning with a strong belt and returned. The apparatus used consisted of two cast iron straps turned to a true circle with inside diameter of 6¼ inches; a ring having 6½ inches outside and 6 inches inside diameter was cut into a number of pieces or blocks. The Ramsbottom ring was inserted inside the blocks and the whole enclosed by the two straps, which were screwed up. The pressure at each block was then found by ascertaining the force required to move each block. In addition, the author suggested a modified ring with the inner surface formed of two half circles differing slightly in their eccentricity from one another as well as from the outer surface. *Safety at Sea*: By Professor F. P. Turvis, Tokyo Imperial University. The author discusses several questions that in his opinion have either been left untouched or have not received sufficient attention by the International Convention on Safety of Life at Sea. His first question is whether the connection between the inner skin and the web-frames should not be rather slight, the inner skin being stiffened by independent frames; injury to the outer skin and the web-frames would then not necessarily involve any part of the inner skin. Another important question raised by the author is the practicability of transverse bulkheads without watertight doors, and he cites two cases in which each stokehold has its own bunkers and communication along the level of the stokehold floor is therefore not urgent. Various other questions were discussed dealing with watertight decks and the operation of watertight doors, etc. 15 illustrations. 3,300 words.—*Engineering,* July 24.

The Sub-Division of Ships.—In a discussion outlining various considerations of the Convention for the Safety of Life at Sea, the author reviews some of the important decisions arrived at by the committee on sub-division. The broad basis on which the whole question of sub-division was considered and which includes those of bulkheads, double bottoms, watertight doors, etc., was that ships be as efficiently subdivided as possible, having regard to the nature of the service for which they are intended. The regulations regarding sub-divisions are entirely independent of other sections of the conference report, and have no connection with safety of navigation or life-saving appliances, each of which is to form its own ideal. In conclusion the author emphasizes the fact that the apparent incompleteness of the conference rules on construction is mainly due to the magnitude and complexity of the subject of sub-division. What, however, has been clearly laid down is the substitution of a scientific and a logical method of sub-division for the *rule of thumb* systems that have long since outgrown their range of applicability. 3,000 words.—*The Engineer,* June 5.

The Port of Antwerp.—An outline of the past developments of the port of Antwerp, which is said to have existed from prehistoric times as a port for loading and discharging sea-going vessels, forms an introduction to the main part of the article describing the improvements now being made by the municipality. The recent improvements involve the diversion of the River Schelde, eliminating all sharp bends and making the diverted part of uniform width. 4.250 words. 1 illustration.—*The Engineer,* June 26.

Canadian Customs Twin Screw Cruiser Margaret.—The vessel was designed for custom patrol work on the Atlantic coast and built by Messrs. John I. Thornycroft & Company, Ltd., at Southampton. With a ram bow and cruiser stern the *Margaret* is 200 feet overall, 185 feet between perpendiculars, 32 feet molded breadth and is limited to a draft of 10 feet 6 inches when carrying 175 tons. The hull is stiffened to resist ice and the shaft is housed in the hull for its entire length. The propelling machinery consists of two sets of vertical reciprocating, triple expansion engines, having a combined indicated horsepower of 2,000 at 180 revolutions per minute. Each engine has an independent steam-turning engine and alternative hand gear. The condensers are of the surface type and receive circulating water from two independent centrifugal pumps driven by vertical open-type engines. Steam is supplied at 220 pounds per square inch working pressure by two water-tube boilers, each having 3,297 square feet of heating surface and 60.4 square feet of grate area. The bunkers are made oil tight and have a capacity of 200 tons, giving a range of nearly 2,000 miles at full speed, and about 4,000 miles at an economical speed. That the vessel is very completely fitted up is seen from a description of auxiliaries and equipment besides the comfortable accommodations and conveniences for officers, crew, etc. There is a large wireless telegraphy instrument and an electric installation which, in addition to supplying current to the wireless and general lighting, supplies current to a 24-inch projecting searchlight fitted in the crow's nest on the foremast. On the forecastle deck there are two 6-pounder quick-firing guns of the Vickers type, having telescopic sights. The boat is rigged as a fore-and-aft schooner, having two pole masts, the lower part of each being made of steel and the upper or topmasts of wood. The foremost is fitted with a staysail and the mainmast with a staysail and trysail for use in cases of emergency. 28 illustrations. 2,400 words.—*Engineering,* September 4.

Ice-Breaking Railway Train Ferry Leonard.—Messrs. Cammell Laird & Company recently completed at their naval works at Birkenhead an ice-breaking steam railway train ferry for the Commissioners of the Transcontinental Railway of Canada. The vessel is designed for the special service of transporting passenger railway trains or freight trains across the St. Lawrence River at all seasons of the year between Quebec and Levis. Designed to carry a train of 1,285 tons, the *Leonard* is 326 feet long, 66 feet 9½ inches extreme breadth, with a mean draft of 15 feet. The vessel is of the twin screw type with an ice-breaking propeller at the forward end. The special feature of the design is the elevating car deck, with a double track, whose height can be varied to suit the tidal range of the St. Lawrence River. This deck is arranged above the main deck of the vessel, and is carried on ten transverse girders, the ends of which each rest on a large nut, and the revolving of a vertical screw causes the nuts to raise or lower the deck to suit the various tide conditions. These vertical screws are hung from ball-bearings supported on strong columns stayed by lattice buttresses and bracing against fore and aft movement. The load on each of these columns is distributed to the keel of the ship by means of specially strong-braced struts in way of each column below the main deck. At each end of the tidal deck an adjustable hinged gangway is suspended by means of triple purchases from struts fixed on the deck, and each gangway is fitted with a special electric motor for raising or lowering it. The machinery for raising or lowering the tidal deck is placed amidships and is of special construction throughout. The engine is of the four-cylinder, high-pressure type, driving through double helical spur-wheels, a second motion shaft running athwartships. At each end of this shaft mitre wheels are arranged for driving the fore and aft line shafting arranged on both port and starboard sides of the vessel. At equal distances along this shafting, worm and wheel gearing is fitted for turning the vertical lifting screws, which are driven through a loose forged steel sleeve and sliding key arrangement fitted into the boss of the wheel. A promenade is arranged all around above the tidal deck and carries a bridge platform at the forward end with pilot house and chart room. Accommodations for officers and crew are arranged below the main deck forward. The propelling machinery is of a design fitted by the firm to a large number of merchant ships and consists of two sets of triple expansion, surface-condensing, reciprocating engines designed to run at 120 revolutions per minute. The propellers and shafting have been made specially strong to withstand shock from striking ice. At the forward end of the vessel a set of compound surface-condensing engines is fitted, driving a nickel-steel propeller for clearing ice at the bow. Steam is supplied throughout by eight single-ended boilers working under natural draft and at a working pressure of 165 pounds per square inch. 9 illustrations. 1,600 words.—*Engineering,* August 14.

Oil-Carrying Steamers.—Comparing the recent *San Isidoro,* one of a large new fleet of oil-carrying steamers for the Eagle Oil Transport Company for the oversea conveyance of Mexican oil, the article traces the growth in size of oil-tankers and particularly the economy resulting from increased capacity. This growth is very strikingly shown by the help of tabulated results taken from actual practice. Following this, as an example of the present day practice in this type of vessel, is a complete description of the *San Isidoro.* This vessel was built on the Isherwood system of longitudinal framing at the yards of Sir W. G. Armstrong, Whitworth & Company, Ltd., who have completed more than 100 vessels of this class. She is 548 feet long overall, 66 feet 7 inches extreme breadth, and has a mean draft in service of 28 feet, with a deadweight carrying capacity of 12,350 tons. The propelling machinery consists of one quadruple expansion vertical reciprocating steam engine, and was supplied by the North-Eastern Marine Engineering Company. Steam is supplied at 220 pounds pressure per square inch by four Scotch boilers fitted with Howden's system of forced draft. The Wallsend Howden oil-fuel-burning installation was fitted on each boiler by the Wallsend Slipway & Engineering Company, Ltd. The bulk oil is carried in twelve tanks between forward and after cofferdams with the machinery space aft. The tanks are divided equally in three parts by two pump rooms, forming practically two auxiliary cofferdams. There is also supplied a means for carrying miscellaneous cargo if the specific gravity of the oil should be low. The pumps for oil fuel are fitted in an isolated pump room, thus keeping the boiler room as clear as possible from any leakage from pipe joints, etc. 14 illustrations. 2,800 words.—*Engineering,* August 7.

New Books for the Marine Engineer's Library

Aids to Navigation—Annual Directories—Jane's Fighting Ships for 1914—New Edition of Machinists' Handbook

RULES OF THE ROAD AT SEA BY DIAGRAM. By Charles Longstreth. Size, 4⅞ by 7¼ inches. Pages, 28. Numerous illustrations. Philadelphia, 1914: Elliott Curtis.

As a study of the printed Rules of the Road at Sea are likely to be confusing to a novice, Mr. Longstreth has illustrated by means of diagrams the International Rules and also the Inland and Pilot Rules where they add to or conflict with the International Rules. The pamphlet will aid materially in explaining to motor boat owners the rules of the road.

STATE PILOTS AND MARITIME VIRGINIA. By Charles Frederick Stansbury. Size, 11 by 8 inches. Pages, 50. Numerous illustrations. New York, 1914: The Mab Press.

As far back as 1714, an old English pilot law was passed, many of the provisions of which are incorporated in the state pilot laws of to-day. That pilots are necessary is shown by the accounts of numerous accidents which might have been avoided by means of a pilot. In this book the schooling and qualifications of pilots are explained; and in connection with these topics, maritime Virginia is discussed and illustrated to show her importance, particularly in the line of shipbuilding.

BEESON'S MARINE DIRECTORY OF THE NORTHWESTERN LAKES. By Harvey C. Beeson. Size, 6¾ by 9¾ inches. Pages, 270. Numerous illustrations. Chicago, 1914: Harvey C. Beeson. Price, $5.00.

The twenty-eighth annual number of this directory includes many articles of interest, in addition to its usual lists of vessels, engines and boilers, steamboat lines, grain elevators and marine associations, both American and Canadian, on the Great Lakes. Navigation for the season of 1914 opened very slowly, the demand for any class of tonnage being practically nil. Fully 30 percent of the lake tonnage was idle on June 25, the date on which this directory went to press, and most of the work in the lake shipyards was confined to repair work.

THE CANAL TOLLS AND AMERICAN SHIPPING. By Lewis Nixon. Size, 4¾ by 7⅜ inches. Pages, 243. New York, 1914: McBride, Nast & Co. Price, $1.25 net.

In order to give an impartial examination of the different interpretations to the meaning of the Hay-Pauncefote Treaty, the author has given within the brief limits of this book a general analysis of the treaty's provisions, together with a review of both sides of the controversy. All of the State papers that show the development of the treaty are given in full. This book is a timely contribution to the general information available on this important subject and emphasizes some points of view which might be overlooked in an attempt to make an extensive study of the voluminous addresses and papers which have been published regarding it.

AMERICAN MACHINISTS' HAND BOOK AND DICTIONARY OF SHOP TERMS. Second edition. By Fred H. Colvin, A. S. M. E., and Frank A. Stanley, A. S. M. E. Size, 4 by 6¾ inches. Pages, 672. Numerous illustrations. New York, 1914: McGraw-Hill Book Co., Inc. Price, $3.00 net.

Everyone engaged in mechanical work of any kind, whether in the shop or drawing room, frequently requires information that is not readily available. This book, therefore, has been compiled to serve as a reference book of machine shop and drawing room data, together with methods and definitions. This new edition has been thoroughly revised and contains 160 pages of additional matter. The headings under which the data are classified are as follows: Screw Threads, Pipe and Pipe Threads, Twist Drills and Taps, Files, Work Benches, Soldering, Gearing, Milling and Mill Cutters, Cold Saws, Turning and Boring, Grinding and Lapping, Oilstones and Their Uses, Screw Machine Tools, Speeds and Feeds, Punch Press Tools, Broaches and Broaching, Bolts, Nuts and Screws, Miscellaneous Tables, Calipering and Fitting, Tapers and Dovetails, Shop and Drawing Room Standards, Wire Gages and Stock Weights, Horsepower, Belts and Shafting, Steel and Other Metals, Steam Hammers and Drop Forging, Knots, Eye Bolts, Ropes and Chains, General Reference Tables, Shop Trigonometry and an illustrated dictionary of Shop Terms.

FIGHTING SHIPS FOR 1914. Seventeenth year of issue. Edited by Fred T. Jane. Size, 12½ by 7½ inches. Pages, 505. Numerous illustrations. London, E. C., 1914: Sampson Low, Marston & Co., Ltd. Price, 21s. net.

In accordance with previous issues of this well-known naval manual, the main part of the book is given over to a tabulation of data regarding the complete naval fleets of the world, arranged in the order of the naval powers of the nations. The information is given in convenient tabular form and up-to-date photographs of most of the important vessels are given, together with diagrams showing the arrangement of armor, and armament of the different types of ships. Silhouettes of different classes of vessels in all navies are given for identification purposes at sea, together with letters for signal purposes arranged on a uniform system. Part II of the book, which comprises thirty pages, contains a fully illustrated article by C. De Grave Sells, M. Inst. C. E, on the Progress of Warship Engineering. This article discusses the latest developments in propelling machinery, including the Zoelly and Belluzzo turbines, geared turbines, Niclausse, Belleville and Yarrow boilers, Diesel engines and a great many of the auxiliaries, including ventilating and refrigerating machinery. Part III, which is arranged by W. A. Bieber, is a silhouette index of the merchant ships of the world.

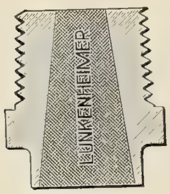
NAVIGATION. By Captain P. S. Thompson, F. R. A. S. Size, 5¾ by 8¾ inches. Pages, 56. New York and London, 1913: Longmans, Green & Co.

Captain Thompson explains in this book a method of finding a ship's position at sea by one observation only. Where two observations have to be taken, a delay of two or three hours must take place to allow of a change of azimuth before the computation can be completed. According to Captain Thompson's method, these disadvantages are avoided, a ship's position being fixed by an altitude of either sun, moon, star or planet at any hour of the night and at almost every hour of the day when the atmosphere and weather are suitable for observation. The entire computation can be made by a navigator in a few minutes. A well-known formula is used for finding the hour angles, two latitudes being assumed. The difference in the hour angles is taken and by proportion a correction is found which, applied to one of the hour angles, gives the correct hour angle. The true latitude is found by another proportion in which also the latitude and hour angles form the terms. Then, with these true quantities, the ship's time is easily determined and the Greenwich date and time having been noted when the observation was taken, the difference between the times gives the longitude, which together with the true longitude when laid on the chart, fixes the ship's position. Numerous examples are worked out to show the method of computation.

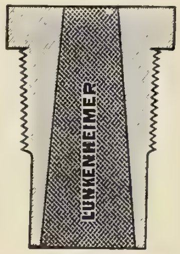
ENGINEERING SPECIALTIES

Lunkenheimer Fusible Plugs

During the latter part of July, 1914, the Department of Commerce, Steamboat Inspection Service, Washington, D. C., by means of a circular letter dated July 30, 1914, File No. 1234, published a set of rules governing the construction of fusible plugs, these rules having become effective June 25, 1914. The Lunkenheimer Company recently designed the two patterns as illustrated to comply



Inside Pattern



Outside Pattern

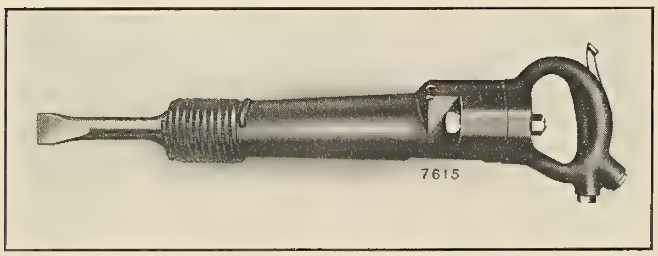
with these rules, and they were accepted by the office of the Supervising Inspector General on August 3, 1914.

Both the inside and outside patterns are made in sizes 3/8-inch to 1 1/2 inches, inclusive. The 1/2-inch size and larger also comply with the boiler laws of the States of Indiana, Ohio, Massachusetts and Wisconsin. The outside pattern, in sizes 3/4-inch and 1 inch, can be had in two sizes as regards the diameter of the threads, one size being slightly larger in diameter than the standard 3/4-inch and 1-inch size of pipe thread, and the other still larger. The object of these two off-size diameter threaded plugs is to accommodate incorrectly tapped or retapped holes.

A New Rivet Buster

While assembling structural members, sheet metal work, riveted pipe, etc., either in the shop or in the field, it often occurs that rivets must be removed after being driven into place, in order to permit of some modification of construction or because they were improperly driven or incorrectly placed. A cold chisel and sledge is often used to knock off the rivet head, however. This method is not only slow and awkward, but may actually result in injury to the work.

Pneumatic chipping hammers are probably the handiest tools for use where a large number of rivet heads have



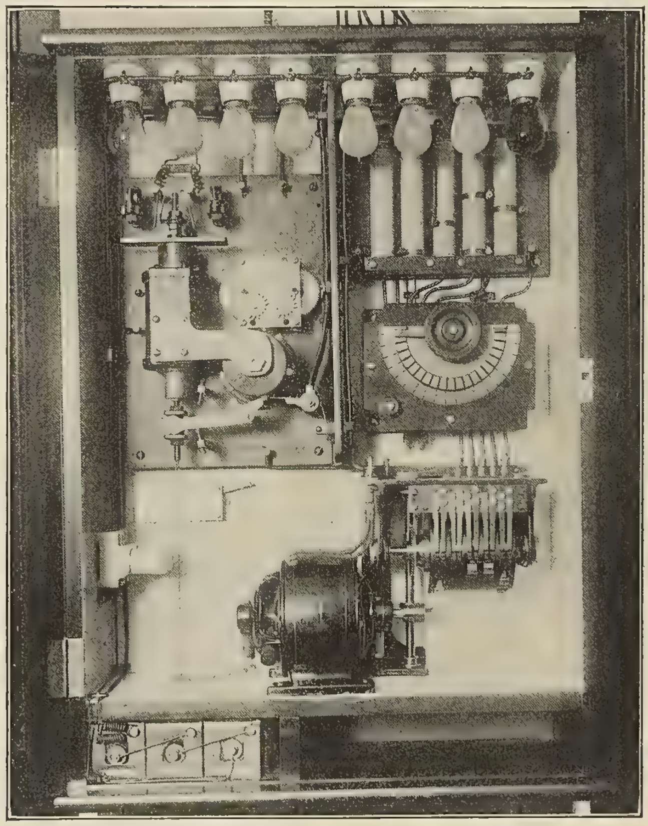
"Little David" Rivet Buster

to be removed. The common procedure with large rivets is to cut a slot across the rivet head, similar to the slot in a round-headed screw. Then with two light blows, one on either side, the rivet head is broken off with little difficulty. Where rivets must be removed only occasionally, however, the trouble of keeping a pneumatic chipping hammer always at hand for only occasional use precludes its more general employment under such circumstances.

Appreciating these conditions, the Ingersoll-Rand Company, 11 Broadway, New York City, have brought out the "Little David" rivet buster, which is made to be used with the regular line of "Little David" pneumatic riveting hammers. It is but an instant's work to remove the rivet set and insert the rivet buster in the nozzle of the hammer. The end of the device is similar to that of the regular rivet set and is designed so that it can be held in place by the safety retaining spring, which is also a recent improvement on "Little David" riveters. This safety feature, it is claimed, absolutely prevents the accidental ejection of the set or chisel while the tool is in operation. The chisel end of the buster is of a size and shape found to be most suitable for its purpose. It is also useful for removing burrs or other defects from the metal. It is of such a small size that it can be carried in the workman's pocket without inconvenience and is always at hand when needed.

Mechanically Directed Firemen

The problem of eliminating all regulations requiring the exercise of reason or judgment and mechanically directing ignorant firemen has been solved by the Bonner Automatic Timer, an electrically actuated mechanism designated to produce in definite succession and at predetermined intervals a continuity of impulse which may be utilized for signaling purposes. This apparatus is manufactured and sold by the Merchant Engineers' Corpora-



Automatic Timer for Firemen

tion, New York. The signaling is accomplished by the flashing of numbered lights or ringing gongs, or both, for the purpose of indicating the periods at which certain duties shall be performed.

The apparatus consists essentially of four parts, or units: First, a selecting switch of rotating lever type with external knob handle and indicator and internal roving bridge, through which connection is made across the different series of contact points; second, a frequency drum

operated through a high to low reduction gear train by direct current motor; third, a sequence drum constantly maintained by a compound spring motor in a condition of carefully calculated torque, this in turn being regulated and controlled by an escapement lever operated by solenoid energized by intermittent impulse from the frequency drum; fourth, the field indicators, consisting of lamp signals, gongs, semaphores or other electrically actuated mechanical apparatus arranged singly or in groups, as may be required.

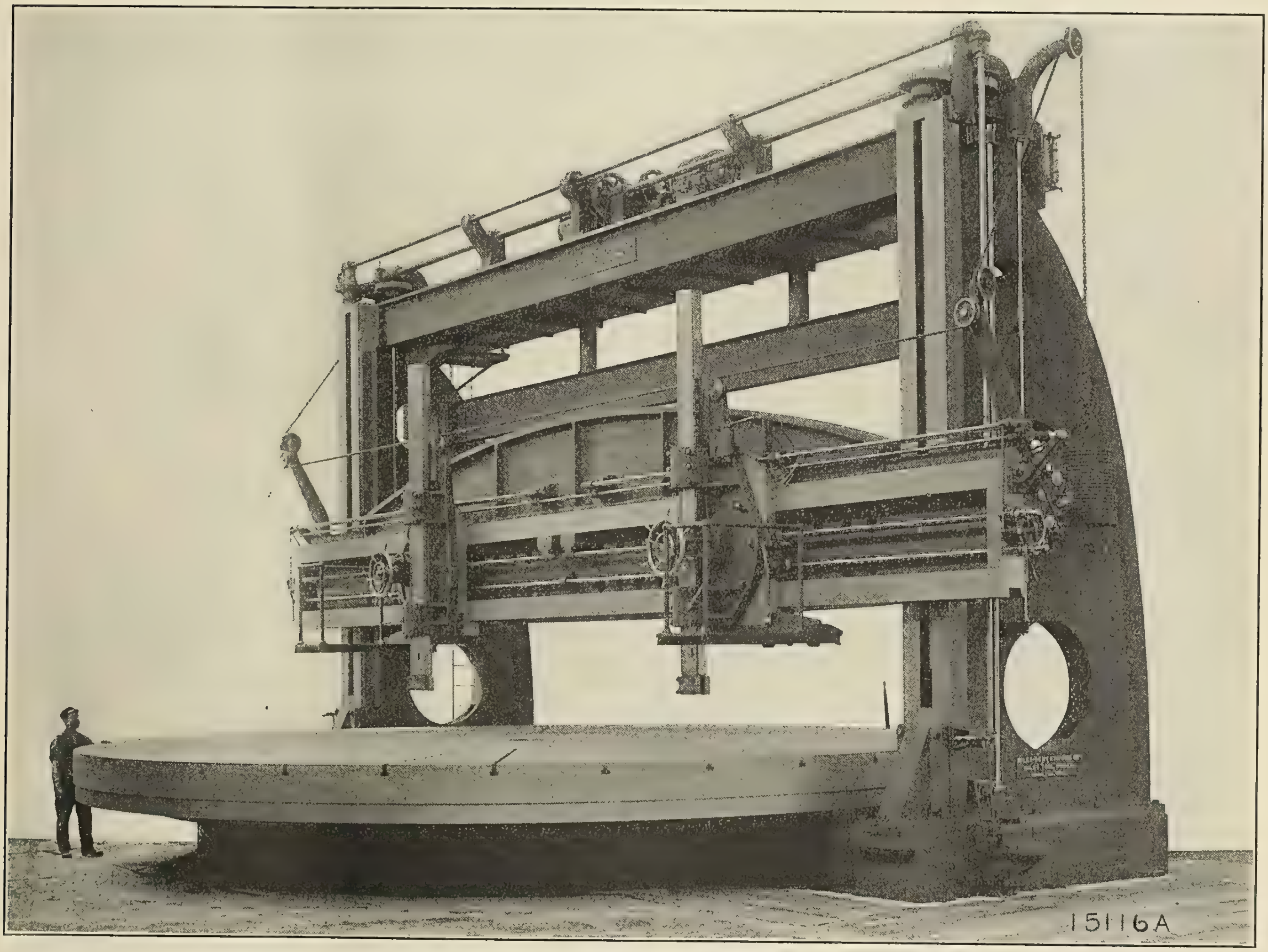
When used as a signaling device, as, for instance, in directing the operation of a boiler plant, having determined by test or otherwise the frequency with which the furnace should be fired in order to produce the requisite amount of steam, the engineer can indicate his requirements by setting the index of the "selecting switch" at the point corresponding to such frequency, the apparatus automatically producing the proper signals at a nearby or distant point.

On the dial plate of the "selecting switch" of this timer there is a series of numbered registrations at which points the index may be set to secure the different indications, which vary in periodic frequency from forty-five seconds to ten minutes.

It may be noted also that this timer is fitted with a tally mechanism by means of which the engineer can easily determine the exact amount of coal or other commodity consumed or handled during a given period.

Largest Boring Mill in America Installed at the Brooklyn Navy Yard

At the Brooklyn Navy Yard there has recently been completed the installation of the largest boring mill that has ever been built in the United States. This machine was made by the Niles-Bement-Pond Company, at the Niles Works, Hamilton, Ohio. It swings 36 feet in diameter and has 12 feet under the tools. The great swing of this machine is required for finishing the tracks of the turrets carrying the 14- and 16-inch guns of the new battleships. The mill will also be used for boring cylinders and machining cases of the steam turbines for the war vessels.



Cross-Rail Boring Mill, with 36-Foot Swing, Recently Installed at the Brooklyn Navy Yard

The significant feature about the size of this mill is that it is not of the so-called "extension" type, but it is a regular cross-rail machine with an actual swing of 36 feet 2 inches with the housings in a fixed position. An idea of the size and massiveness can be gained from the fact that the total net weight, including motors, is 665,000 pounds or 300 tons.

The table is designed to carry a weight of over 200,000 pounds. The extreme size of the table, 34 feet diameter, made it necessary to cast it in three parts. The three sections of table weighed 225,000 pounds. The table is supported on conical rollers running in a circular track 24 feet in diameter, sunk in the bed. The rollers are of high carbon steel and fitted to circular guide frames to insure alinement of the rollers. In addition, the table

rests in an annular adjustable bearing ring surrounding the central spindle. The bearing ring is adjusted vertically by steel screws. The spindle is centered in the bed by an adjustable conical bush. The table tracks and spindle have forced lubrication from a pump operated from the main driving motor.

The table is fitted with a spur gear 28 feet in diameter which is a semi-steel casting, with teeth cut from the solid. It is driven by means of two forged steel pinions, placed on opposite sides of the mill.

The main part of the bed is made in two sections. There are two bed extensions attached to the main bed. The whole bed weighed 69,000 pounds in the rough, and the other section 48,600 pounds. The table tracks are rigidly supported by the vertical webs of the bed.

The housings are box castings connected at the top by a heavy cross brace. Rigidity is further increased by a steel girder connecting the housings. Each housing weighed in the rough 32,000 pounds.

The cross-rail is about 46 feet long and weighed 85,000 pounds in the rough. It is a box casting. Bolted to the top of the cross-rail is a camber beam designed to stiffen the cross-rail and take up the sag due to the great weight of the cross-rail and the heads. The combined depth of the cross-rail and the camber is 8 feet. The rail is raised and lowered by means of a 30 horsepower motor located on the top cross brace and connected to four elevating screws of large diameter working in bronze nuts.

The cross-rail is fitted with two heads for boring and turning. The heads are right and left, so arranged that either can be moved to the center. They are provided with graduating swivels, with worm gearing for setting them over to any angle on either side of the vertical of 30 degrees or less.

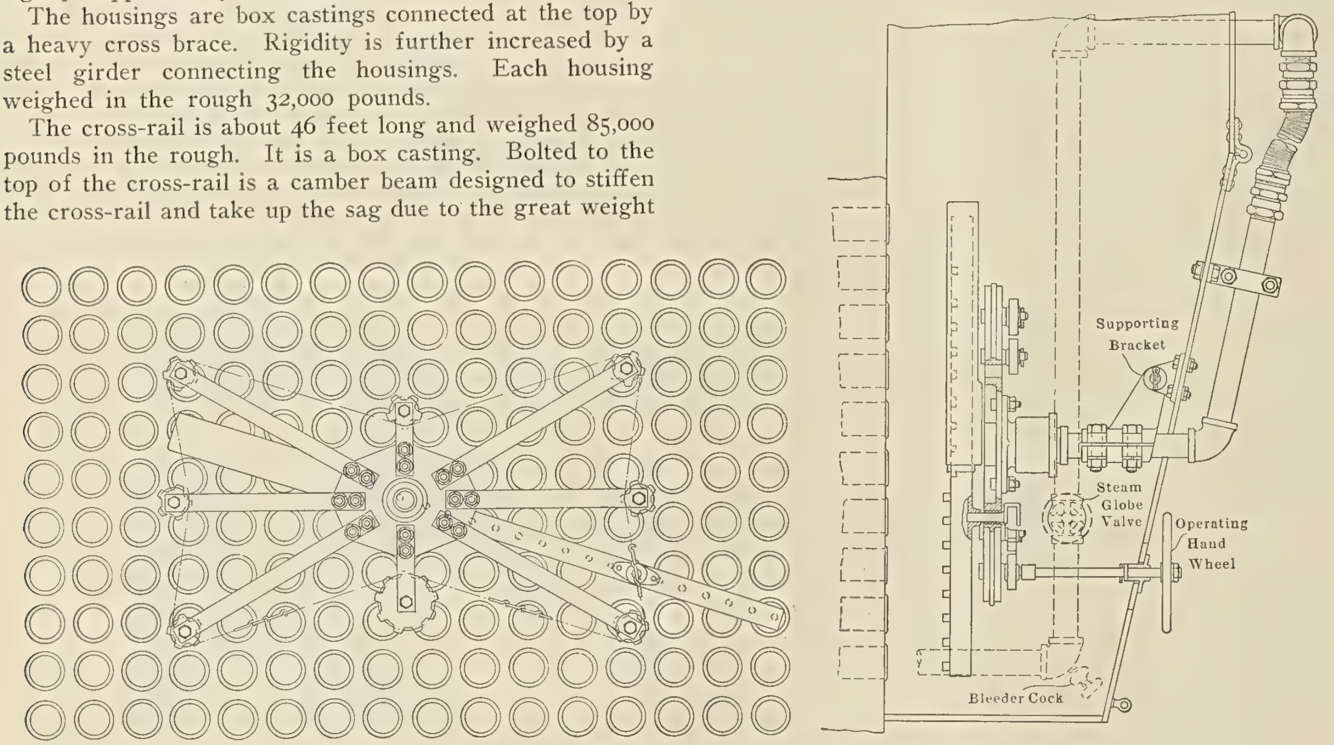
The heads and bars are provided with rapid power traverse, as well as hand movement for close adjustment. The rapid traverse is operated by a 10 horsepower motor located on the top brace. The control of these operations, and also the engaging and disengaging of feeds, is from a platform attached to each head, upon which the operator stands. The operating levers are interlocking, so that the rapid traverse cannot be engaged for one head unless it is disengaged from the other, making it impossible for the operator on one head to accidentally move the opposite one.

Eight reversible power feeds are provided for the bars and are operative in a vertical or angular direction. The feeds for each head are entirely independent and positive. Means are provided by friction clutches to prevent the breakage of feed gearing, should either bar or saddle encounter obstruction.

The main drive is by a 75 horsepower motor, and speeds are provided for boring, turning and facing operations.

The Planet Soot Blower

The Bennett-Dluge Company, Detroit, Mich., has placed on the market a device known as the Planet blower for cleaning the tubes of horizontal return tubular or Scotch boilers. The blower is a self-contained unit mounted with a bracket attachment on the uptake door. It is operated from outside by means of a hand wheel, and is supplied with steam, the steam valve and bleeder being within easy reach. The soot is blown from the front of the boiler to the rear. As shown in the illustration, there is a telescopic jet arm, which is caused to traverse the flue sheet area by means of a cam track which brings the jets directly in front of the tubes. The steam jets are at close range to the flue sheet, and, on account of the number of jets which are blowing directly into the tubes at the same time, a strong draft is set up, which insures a thorough cleaning of the tubes.



Planet Soot Blower Applied to a Scotch Boiler

Personal

W. S. Hardy has resigned as chief engineer of the tug *James H. Scott*, of Albany, N. Y.

Nicholas Snyder has resigned as chief engineer of the tug *Marguerite* of the Great Lakes Dock & Dredge Company.

Jacob Jones has resigned as chief engineer of the steamer *Trojan*, of the Hudson Navigation Company, New York.

John H. Ward, formerly chief engineer of the steamer *Old Colony*, of Fall River, Mass., has accepted a position on the steamer *Howard Co.*, of West Haven, Conn.

Alexander Ryder, of New Haven, Conn., has accepted a position as chief engineer and electrician at the Hotel Garde, New Haven, Conn.

Edward O. Cutler, formerly assistant to the superintendent of construction at the Bath Iron Works, Bath, Me., is now assistant manager of the Craig Shipbuilding Company, Long Beach, Cal.

William Hurst has been appointed engineer of the tow boat *Eagan* of the West Kentucky Coal Company, Cairo, Ill. This boat is being sent South with a large tow of coal for Southern markets.

M. E. Farr, of Detroit, Mich., has been elected vice-president of the American Shipbuilding Company, Cleveland, Ohio, succeeding Mr. Edward Smith, who has been elected president of the company.

William Roach, of Buffalo, N. Y., is chief engineer of the giant dredge suction *Massachusetts,* in service on the Hudson River between Albany and Troy, N. Y. Captain Otto Erickson is in command of the dredge.

W. G. Eckert, first assistant engineer of the river steamer *Adirondack,* of the Hudson Navigation Company, New York, has been promoted to the position of chief engineer of the steamer *Trojan* of the same company.

Edward Elliott has been appointed assistant engineer of the transfer steamer *St. Genevieve,* which is owned by the Illinois Southern Railroad and used for transferring railway cars across the Mississippi River below St. Louis, Mo.

Peter Deitz has been appointed chief engineer of the tug *Yosephie.* This tug, which was formerly chartered by the United States Government, has been taken to Syracuse, N. Y., for State work. Captain Albert Hotaling has charge of the tug.

Rear Admiral Nathaniel Usher, formerly commandant of the Norfolk Navy Yard, Norfolk, Va., has been appointed commandant of the New York Navy Yard, Brooklyn, N. Y., succeeding Captain Albert Gleaves, who has been detailed to command the battleship *Utah.*

Jacob Holmes, of New York, is chief engineer of the steam yacht *Courier,* owned by Mr. Galt, of the flour firm of Galt & Company, of Washington, D. C. The yacht is now being prepared for an extensive voyage to South American ports with Mr. Galt and his family on board.

Jacob Reed, chief engineer of the steam yacht *Niagara,* owned by Howard Gould, of New York, and chartered several months ago by Joseph Leiter, of Washington, D. C., for a cruise around the world, reached Washington early in September on the return of the yacht to home ports.

Henry Stammell, formerly chief engineer of the steamer *Chester,* which was burned recently at New Hamburg, N. Y., has been appointed chief engineer of the tug *George E. Lattimer..* George McCabe, captain of the *Chester,* has been transferred to the U. S. steamer *General Totten.*

George T. Cahill, formerly chief engineer of the tug *George E. Lattimer,* has accepted a position as chief engineer of the steamer *Marguerite,* owned by the Great Lakes Dock & Dredge Company. Captain George Trei, formerly in the U. S. Government service, is master of this steamer.

George Magee has been appointed chief engineer of the new ferryboat *Three States,* which has just been completed by the Howard Shipbuilding Company, Louisville, Ky., for service between Cairo, Ill., Birds Point, Mo., and Wickliffe, Ky. Mr. Magee has just left Cairo, Ill., for Louisville to bring out the new boat.

William Kersey is chief engineer of the steam yacht *Gaivoto,* owned by John R. Dos Passos, of New York. While coming up the Potomac River at night recently the propeller of the yacht struck an obstacle and the propeller shaft was broken. The yacht has been towed to Alexandria, Va., where she will be hauled out on a marine railway and repaired.

Victor Matte has been appointed chief engineer of the tug *George W. van Tuyl,* of Albany, N. Y., which was placed in service for the first time this season on August 31. The *George W. van Tuyl* is taking the place of the tug *James H. Scott,* which has been taken to Rondout, N. Y., for repairs to her boiler. Captain William McCann is master of the *George W. van Tuyl.*

Patrick O'Neil, connected with the bolt and rivet department of the Union Iron Works, of San Francisco, Cal., has completed his fiftieth year of continuous service with this company. In recognition of this anniversary John A. McGregor, president of the company, sent Mr. O'Neil a letter of thanks for his faithfulness and loyalty, inclosing a check for $1,000 (£205).

R. Earle Anderson, formerly engineer with the Lake Torpedo Boat Company, Bridgeport, Conn., has been appointed general manager of the Augusta-Savannah Navigation Company, Augusta, Ga., in charge of the Augusta Barge Line. Mr. Anderson was formerly connected with the Bureau of Construction and Repair, Navy Department, Washington, D. C., and is well known as a contributor to this journal.

Edward Smith, of Buffalo, N. Y., formerly vice-president of the American Shipbuilding Company, Cleveland, Ohio, has been elected president of the company, succeeding Mr. James C. Wallace, whose resignation was accepted by the board of directors September 23. Mr. Smith was also president of the Great Lakes Towing Company, but has severed his connection with this company to take up the duties of president of the shipbuilding company.

Jeff Burnell has been appointed chief engineer of the steamer *Angler,* which has been in operation on the River View excursion route from Washington, D. C., on the Potomac River during the summer. The *Angler* has now been chartered by the Chesapeake & Potomac Steamboat Company to take the place of the steamer *Wakefield* on the river route while the *Wakefield* is at Newport News for extensive repairs to her hull and machinery. The *Angler* is commanded by Captain Bailey Reed.

Captain I. N. Hibberd, for many years superintendent of the Pacific Coast Steamship Company, has resigned to become general manager of the shipping firm of Sudden & Christenson, San Francisco, Cal. Captain Hibberd will give his attention especially to the coast-to-coast service which has been inaugurated by this firm. This service will be carried on at present by five steamers of from 5,000 to 6,000 tons carrying capacity—the *Peter H. Crowell, J. A. Hooper, Louis K. Thurlow, Montroso* and *Neches,* all practically new vessels. The *J. A. Hooper* left San Francisco September 15 with a cargo of lumber and barley for the Atlantic coast. With the fleet actively in service the company will dispatch a vessel from departure points every three weeks.

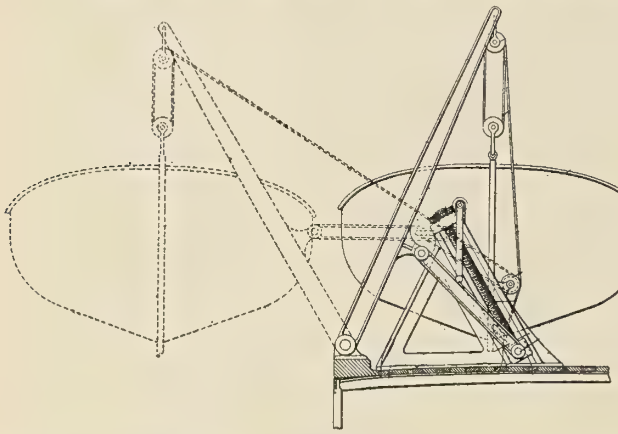
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,105,594. DAVIT FOR LOWERING AND RAISING SHIPS' BOATS. ANDREAS P. LUNDIN AND HARRY W. BROADY, OF BAYSIDE, N. Y.; SAID BROADY ASSIGNOR TO SAID LUNDIN.

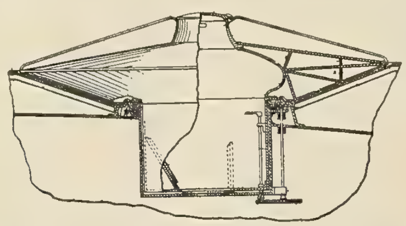
Claim 1.—The combination with a davit arm pivoted at its lower end to swing freely in a vertical plane to both sides of a perpendicular position, of a frame secured to the deck of a vessel, a screw supported in



said frame in an inclined position to have rotary movement only, a nut threaded on the screw, a link connecting said nut and davit arm and means for rotating the screw. Three claims.

1,103,958. SUBMARINE BOAT. ANTHONY J. GRIFFIN, OF NEW YORK, N. Y.

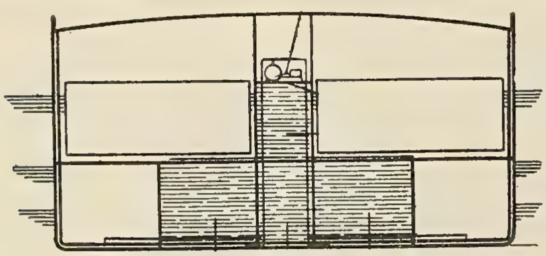
Claim 1.—In combination, a submarine boat having an outer shell and a deck above the outer shell, the deck having an opening therein, and the shell having a well therein located within the margin of the deck opening; a safety chamber for containing occupants of the boat, the



safety chamber having a lower portion entering the well and having an enlarged upper part flaring outward within the deck opening with the outer margin of the chamber substantially flush with the adjacent portions of the deck of the boat; means for releasably securing the safety chamber in place on the boat, and means for releasing the securing means. Twelve claims.

1,107,741. UNIT-CARGO VESSEL. FREDERICK A. BALLIN AND EDWARD H. DODGE, OF PORTLAND, ORE.

Claim 1.—In a vessel provided with an opening hull portion at one end for floating in loaded barges, an upper deck, a load-carrying deck below the upper deck, longitudinal bulkheads inclosing a central submerging compartment above and below the load carrying deck, extending

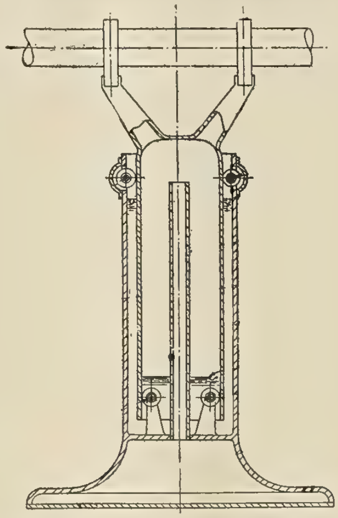


lengthwise of the vessel, the space below the load carrying deck being so divided as to provide reserve buoyancy compartments at the sides of the vessel, supplementary submerging compartments located between such reserve buoyancy compartments and the central submerging compartment, said reserve buoyancy compartments so proportioned that their combined displacement equals the weight of the vessel, said submerging compartments so proportioned that when flooded they will sink the vessel to its loading draft, and when emptied their combined displacement in supplement to that of said reserve buoyancy-compartments will place the vessel, with full load, in the condition of its normal draft, and means for flooding said submerging compartments. Twelve claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

5405/1914. MOUNTINGS FOR INSTRUMENTS ON BOARD SHIP. PROF. A. BARR, OF THE UNIVERSITY OF GLASGOW AND W. STROUD.

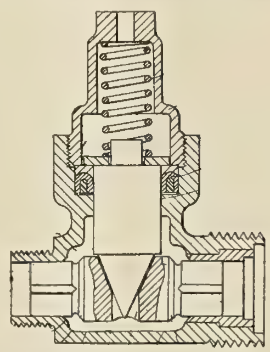
Claim.—A mounting, for supporting instruments on board ship by means of a volume of air maintained under pressure by the weight of the load acting upon the air in opposition to a head of liquid, is characterized by the volume of air being great in comparison with the change of volume due to any probable vertical displacement of the mounting caused by vibrations. The mounting consists of a tank containing liquid, a reservoir having a communication near the head of the tank, an inverted vessel placed within the tank upon which the instrument is carried, the inverted vessel and connected parts being sup-



ported by air contained within the vessel, and the reservoir maintained under pressure by the weight of the load acting in opposition to the head of liquid contained in the tank.

15,398/1913. IMPROVEMENTS IN VALVES FOR HYDRAULIC SYSTEMS, ESPECIALLY SUCH SYSTEMS AS ARE APPLICABLE FOR OPERATING BULKHEAD DOORS AND THE LIKE. J. STONE & CO., LTD., DEPTFORD, F. J. PIKE AND H. NEVILLE, ALL IN THE COUNTY OF KENT.

Relates to improvements in valves for hydraulic systems for operating bulkhead doors and to an improved means for automatically putting the ram of the hydraulic cylinder or cylinders operating each door in equilibrium upon the cessation or failure of hydraulic pressure in the mains so that the door or device may be capable of manual operation with per-



fect freedom. It consists of a casing having two oppositely situated openings leading therefrom which are placed in communication one with each end of the cylinder in the case of a system employing a double-acting cylinder. Within the chamber is placed a double-acting valve with valve faces formed on the ends and supported in axial alignment with annular seatings. In order to hold the valve in a midway position upon the failure of pressure in the system there is provided a plunger which is projected into the valve holding same in midway position by the action of the spring, as clearly shown in the drawing. Modifications are described.

6,380/1913. IMPROVEMENTS IN DAVITS. THE MARTIN PATENT DAVIT CO., LTD., of 9 UNION COURT, LIVERPOOL, AND E. S. GLADSTONE.

The invention consists in making the upper guiding track and the lower guiding track rectilinear, and in arranging the two tracks at such an angle that the davit as it moves along them receives the required tilt. The transverse shaft which connects the two davits of a pair is placed as low down on the davits as possible and carries pinions engaging holes in the under surface of the lower track, while a plain wheel on the davit runs on the upper surface of the upper track. The lower track is inclined upwardly from inboard to outboard, while the upper track is inclined downwardly. With such an arrangement the head of the davit can be caused to descend slightly as the davit moves out through the lower end rises slightly, with the result that both outboard and inboard movements are effected very easily.

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Naval Architects' Meeting The preliminary programme printed elsewhere in this issue of the annual meeting of the Society of Naval Architects and Marine Engineers, which will be held in the Engineering Societies' Building, New York City, December 10 and 11, indicates that a wide range of subjects will be brought up for discussion. Two excellent papers giving the results obtained from model experiments show the effect on resistance of various changes of form of a ship's hull, while other important subjects include electric propulsion, oil engines and the protection of vessels against disaster by collision and fire. In view of the fact that this meeting brings together a large number of the men best equipped to discuss matters relating to shipping and shipbuilding, it is to be hoped that at least a part of the meeting will be devoted to a discussion of the question of upbuilding the American merchant marine in foreign trade. Never before has the need for action in this direction been more urgent, and the opportunity should not be lost for formulating the most feasible plans for aiding this movement.

Shallow Draft Boats In devoting this issue almost wholly to the subject of shallow-draft boats, we wish to emphasize again a point which we have brought out many times regarding the development of inland navigation. The prime requisites for successful inland navigation are improved waterways, efficient floating equipment and adequate terminal facilities. Much has already been done by the Government in improving the navigable rivers of the United States, and, with the completion of the projects which are now in hand for establishing and maintaining channels of a uniform depth on such rivers as the Mississippi, Ohio and Missouri, one of the chief obstacles to the growth of inland navigation will have been overcome. A number of changes are also being made in the design of river boats by the adoption of improved methods of propulsion in towboats and the development of self-propelled barges, so that the cost of transportation on inland waters will probably be brought to a favorable competitive basis with railway transportation. The third requirement, however, that of adequate terminals along rivers and inland waters, has progressed very little, if at all, in most cases. For an adequate terminal, besides economical means for handling freight, the greatest necessity is co-operation with railway, steamship and other transportation companies for transshipment of freight.

Three Cash Prizes Cash prizes of $15, $10 and $5 are hereby offered for the three best letters sent by marine engineers to the Contest Editor of this journal before January 1, 1915. In addition to the prizes, the winning letters will be paid for at regular space rates when published in the magazine, and all other letters submitted in the contest which do not receive prizes, but which are accepted for publication, will also be paid for at regular space rates. The letters should give some idea or experience gained by the engineer either in his every-day work in the engine room on board ship, or in the building of marine machinery. The field is a wide one, as any subject may be chosen which relates to the design, construction or operation of marine machinery, including boilers, engines, condensers, pumps, piping, evaporators, distillers, winches, steering engines, electrical, refrigerating, heating or ventilating apparatus, and the like. Any reader may send in as many letters as he pleases, and there are no restrictions as to the length of the letter or the subject discussed, although each letter should preferably be short and confined to a single subject.

A Special Naval Reserve In the Administration shipping bill, which will probably be one of the first measures taken up in the next session of Congress, there is a provision giving to the masters, watch officers and seamen employed on the vessels provided for in the measure, who are citizens of the United States, the privilege of enlisting and being enrolled in a special naval reserve. While so enrolled and employed they may receive such pay and relative rank as the President of the United States may prescribe. Whatever disposition may be made of the shipping bill, we are heartily in favor of the establishment of a special naval reserve in which the officers and men shall receive suitable pay and rank from the government in return for their services. If such a measure were made applicable to all foreign-going ships in the American merchant marine, it would not be long before a strong and efficient body of men, thoroughly experienced in the handling of ocean-going vessels, would be available as a most valuable adjunct to the United States navy. At the same time, the payment of the comparatively small sums of money for this pur-

pose by the government would enable American ship owners to place more ships in the foreign-carrying trade, and as a consequence a large part of the immense sums that are now paid annually to foreign ship owners for carrying overseas freight would be kept at home. Under the present conditions it is freely admitted that government aid of some form is practically a necessity in order to overcome the difference in the cost of operation of American and foreign ships; and in considering ways and means of accomplishing this, the proposed scheme of establishing a special naval reserve should be given careful consideration.

Registry of Foreign-Built Vessels Up to October 24, seventy-eight foreign-built vessels, aggregating 272,548 gross tons, were admitted to American registry under the provisions of the amendment to the Panama Canal act, which became a law on August 18. Sixty-seven of these vessels, aggregating 240,257 gross tons, were formerly under British registry, seven, aggregating 26,069 gross tons, were formerly under German registry, and four of 6,222 gross tons were formerly under Belgian registry. With an increase of over a quarter of a million tons in the short space of two months, the American merchant marine is rapidly approaching an important position in the foreign-carrying trade, and it is not unlikely that in the near future English capital will be attracted to American shipping, thereby further strengthening its present position.

The Western River Steamboat The type of vessel known the world over as the western river steamboat was developed to meet the natural conditions on the large western rivers of the United States, and for this reason it is a distinct departure from ordinary steam vessels. On account of low water, the boats plying on the western rivers are frequently aground or are obliged to force their way over sand bars or reefs. In the early days of river navigation, before river improvements were begun by the government, it was practically an everyday matter to encounter in the river such obstacles, and for this reason it was necessary to build a boat which could with its own power cut its way or lift itself over shallow places. Moreover, on account of the sharp bends and changing channels, the boats were required to maneuver constantly, and full backing power was a necessity.

A careful study of the characteristics of the typical western river steamboat will show at once its many advantages for navigation under such conditions. The shape of hull usually follows a more or less standard design, the weights being so distributed that the draft at the stern of the boat is practically the same under all conditions of loading. This is done in order to insure uniform immersion of the stern wheel. Steel is used almost universally now for the construction of the hulls, as it has proved more economical than wood, in spite of the increased cost of a steel boat over a wooden boat. The type of power plant used has been accused from a good many quarters of being inefficient and wasteful; and while to some extent these accusations are true, for the most part the typical western river steamboat is operated with a fair amount of efficiency. The boilers are of a type specially adapted to the river conditions, as the feed water is usually very muddy and contains many impurities; high steam pressures are carried and numerous repairs are needed on the boilers owing chiefly to burned plates or leakage. The engines are of heavy construction, with massive, slow-moving parts, and, as a rule, seldom need repairs. The wear on the moving parts is very slight, and although the stern wheels are constantly striking obstructions, little damage is done to any part except the buckets of the wheels themselves.

Two Important Bills Introduced in Congress

In line with the suggestions made in our last issue urging the enactment of legislation to increase the security of marine mortgages, Judge J. W. Alexander, chairman of the House Committee on Merchant Marine and Fisheries, introduced in the House on October 20 two bills to amend the maritime laws of the United States so as to protect ship owners in the sale or transfer of vessels. The first of these reads as follows:

"That section 4196 of the Revised Statutes of the United States be amended so as to read as follows:

"Sec. 4196. All bills of sale of vessels registered or enrolled, shall set forth the part of the vessel owned by each party selling, and the part conveyed to each party purchasing.

"Where any vessel, registered or enrolled, is subject to any encumbrance, recorded as provided for in Section 4193 of the Revised Statutes of the United States, the existence of such encumbrance shall be noted upon the face of each registry of enrollment and on all abstracts or copies thereof, and when so noted the same shall be conclusively presumed to be notice to any subsequent purchaser; but the failure so to note any such encumbrance shall in no wise diminish the binding force thereof."

The second bill reads as follows:

"That no vessel, registered or enrolled as a vessel of the United States, shall be sold or transferred, in whole or in part, to a subject or citizen of any foreign prince or State, so long as there exists against any such vessel any mortgage, hypothecation or lien recorded as provided by law; and in the event of any such sale, said vessel, together with her tackle, apparel and furnishings, shall be forfeited to the United States, without prejudice, however, to any such encumbrance.

"The person entitled to the benefit of any such encumbrance may file a petition stating his interest in the course of any proceeding for forfeiture, whereupon such order shall be made as will preserve the right of the encum-

brancer in the proceeds of the sale of the vessel thereunder."

These bills should speedily be enacted into law, so that investment in overseas shipping and the transfer of foreign ships to American registry will be thoroughly protected from unnecessary financial losses.

River Towboats in Europe

The report on experimental towboats prepared by a special board of army engineers, which is reviewed elsewhere in this issue, is one of the most valuable documents which has been compiled on the subject of river towboats in recent years, and will well repay a careful study by those engaged in river navigation. The investigation covers many different types of river towboats, barges and methods of towing. The principal navigable rivers of Europe were visited and observations made of the methods of towing and types of boats used in those places.

The prevailing type of towboat on European rivers was found to be the side wheel steamer with compound or triple expansion condensing engines with the two paddle wheels mounted on a single shaft. The stern-wheel towboat, which is the prevailing type in use on the western rivers of the United States, is used only to a limited extent on the large German rivers. The main objection to its use seems to be the liability of the wheel to damage when the boats were swung around in contact with the banks of the river, which for the most part are rocky. On the lower reaches of the German rivers a number of propeller towboats, principally of the twin screw type, are used. On the Rhine, tunnel screw towboats are used in which the screw is only about 66 percent submerged when not in motion, although after starting ahead the tunnel is completely filled with water. Very little backing by the towboat is required, however, so that ample power is developed for this purpose by the submerged portion of the wheel. Most of the barges on the German rivers are of ship-shape models with rather blunt bows and fairly fine lines aft.

Contrary to the conditions on the western rivers of the United States, where most of the towing is down-stream, the preponderance of tonnage handled on the European rivers is up-stream traffic. The methods of towing on different rivers are practically the same. In general, the towboat leads and the barges follow, either single or two or more abreast. Occasionally a barge is placed on each side of the towboat, although this formation is not widely used. The size of the individual tow is always larger along the lower rivers, gradually decreasing in size on the upper reaches.

In the upper parts of some of the German rivers, where rapids are frequent and the current is swift, a novel system of towing is in common use in which chain towboats are used. The chain is laid in the bottom of the river and the towboat is built with both the bow and stern sloping down nearly to the water level. The chain is led in over the bow through a series of fair leads to a power-driven wildcat amidships and then out over the stern in a similar manner. On the Rhone, where even swifter rapids are found, a similar type of towboat is used, with the exception that a wire rope is substituted for the chain, and instead of passing the rope in at the bow over a wildcat or drum and out again at the stern, the wire rope belongs to the individual boat and is wound up and retained on the drum on the up-stream trip and paid out again on the down-stream trip. Each boat carries from 8 to 10 miles of rope, the length of the rope limiting the distance which any boat can cover. The three principal objections to the ordinary chain towboat are the frequent breaking of the chain, causing expensive delays, the difficulty of one tow passing another, and the inefficiency and helplessness of the boat except when attached to the chain. Such boats are still being built, however, although in decreasing numbers, and eventually they will probably be replaced by more powerful modern self-propelled towboats.

Another river in Europe on which is found a distinctive type of towboat is the Volga, in Russia, where Diesel-engined, side-wheel towboats are used to a considerable extent with excellent results. In general appearance these boats resemble the side-wheel steam towboats on the Elbe and Rhine. The engines are of the slow speed, heavy duty type, set athwartships and connected to the paddle shaft by reduction gearing. The fuel consumption averages about .5 pound per horsepower and the weight about 100 pounds per brake horsepower. The saving in weight by such installations on large river boats enables a material reduction in the draft of the boat, while the cheapness of the fuel and the reduction in the operating force as compared with steamboats reduce the cost of operation to a minimum.

In many of the harbors on the German rivers the facilities for loading cargo into and out of barges have been developed to a very high state of efficiency. In ports like Rotterdam, where the requirements are largely for the transfer of freight from a barge to a ship, floating equipment, such as floating cranes, derricks, grain elevators, coal handlers, etc., is used extensively. Special equipment is provided in many places for handling special cargoes, such as coal, ore or grain, while for handling miscellaneous freight a very complete equipment of traveling cranes is generally used.

It is interesting to note that along the lower 355 miles of the river Rhine there were in 1907 sixty-two harbors with a total water area of 2,200 acres, a wharf frontage of 150,000 yards, storehouses to the number of about 400, and handling machinery amounting to 500 cranes, 53 coal tips and 54 elevators, while on the Mississippi, Missouri, Ohio system in the United States, with 3,700 miles of navigable waterways, there is not a single harbor worthy of the name. From the experience gained in investigating conditions abroad, however, the army engineers have come to the conclusion that it is undesirable to install any but the simplest form of cargo-handling appliances on river boats or barges, and that to handle cargoes economically there should be provided efficient terminal facilities.

The Augusta-Savannah Barge Line

Producer Gas Steel Barges Built for Service on the Savannah River—Terminal Facilities at Augusta

BY R. E. ANDERSON, C. E.*

The Augusta-Savannah Navigation Company, of Augusta, Ga., is having constructed for service on the Savannah River two shallow-draft, self-propelled steel barges of the tunnel-stern type, equipped with producer gas engines.

For a great many years Augusta has profited greatly by the traffic conducted on the river, the city being at the head of navigation. Under the United States Army engineers the river has been improved by dredging and by bank protection, and a channel 80 feet wide, with a depth of 5 feet at summer low water, is maintained by the Government. Various companies have operated boats upon the river in competition with the railroads, with the result that Augusta has enjoyed the most favorable freight rates of any inland city in the Southeast.

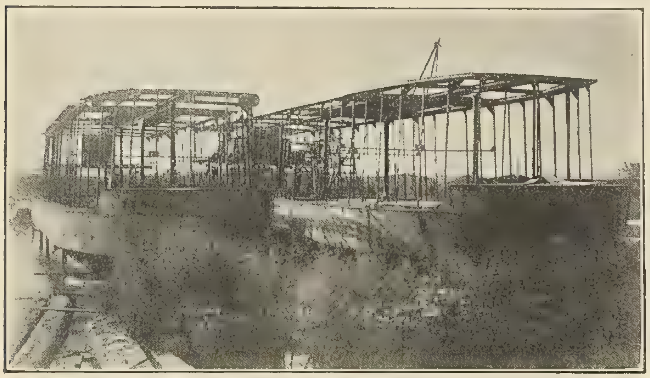


Fig. 1.—Augusta Barges under Construction

For various reasons, however, chiefly on account of neglect and inefficient management, the river route has recently been falling into disfavor with shippers, and river traffic has declined to such an extent that withdrawal of the Government appropriations was seriously contemplated. In order to restore the river traffic, the competition of which with the railroads has been largely responsible for the low freight rates enjoyed by shippers at Augusta, the business men of Augusta have united in a movement which has resulted in the organization of the Augusta-Savannah Navigation Company, to carry on service on the Savannah River. The organization is based on an adequate plan of finance under responsible management. Modern self-propelled barges are being built capable of maintaining schedules and of obtaining favorable insurance rates. Complete traffic arrangements have been made with connecting coastwise steamship lines, and up-to-date terminal facilities are to be provided at Augusta, insuring low stevedoring costs and providing trackage facilities connecting with various railroads entering Augusta. The design of the floating equipment and the Augusta terminal has been worked out by R. C. Wilson, of New Orleans.

Hull Construction

After careful investigation, a vessel of about 300 tons carrying capacity was decided upon, of all-steel construction, with producer-gas propelling machinery. The general dimensions are as follows:

Length	150 feet
Depth	5 "
Draft, loaded	4 "
Breadth	30 "
Cargo capacity, about	300 gross tons

The form is of the usual flat-bottom type, with easy lines aft in way of the tunnels, and with slightly raking stem and "flat-iron" bow, a form of entrance which was adopted in preference to a spoon bow, on account of floating logs and snags.

Fig. 2.—Main Deck of Barge, Looking Aft

The hull is built entirely of medium steel. The side and bottom plating is ¼ inch thick, with lapped seams and butts, and the deck plating is 3/16 inch thick, also with lapped seams and butts. The bilge is square, with a heavy bilge angle on the outside.

The frame spacing is 24 inches, except in the forecastle, where it is reduced to 18 inches. The frames consist of channel-bar floors, to which the vertical angle-bar side frames are bracketed. The floor channels are 5 inches by 6.5 pounds, except at the ends, where they are reduced to 4 inches by 5.25 pounds, and the side frames are 3 inches by 2 inches by ¼ inch, except at the stern, where they are reduced to 2 inches by 2 inches by ¼ inch. The deck beams are 4-inch by 5.25-pound channels, one on every frame. Abaft the cargo house the deck beams are suitably reduced.

Three heavily constructed latticed girders provide longitudinal strength as well as local stiffening. These girders consist of 6-inch by 8-pound channels, fitted on top of the floors and under the deck beams, connected by vertical and diagonal latticing of 3-inch by 3-inch by ¼-inch and 3-inch by 3-inch by ⅜-inch angles. These girders merge into the engine foundations and provide a peculiarly rigid construction.

On the outside of the hull two fender-wales are fitted, consisting of yellow-pine timbers secured to the hull by

* Member of American Society of Naval Architects and Marine Engineers.

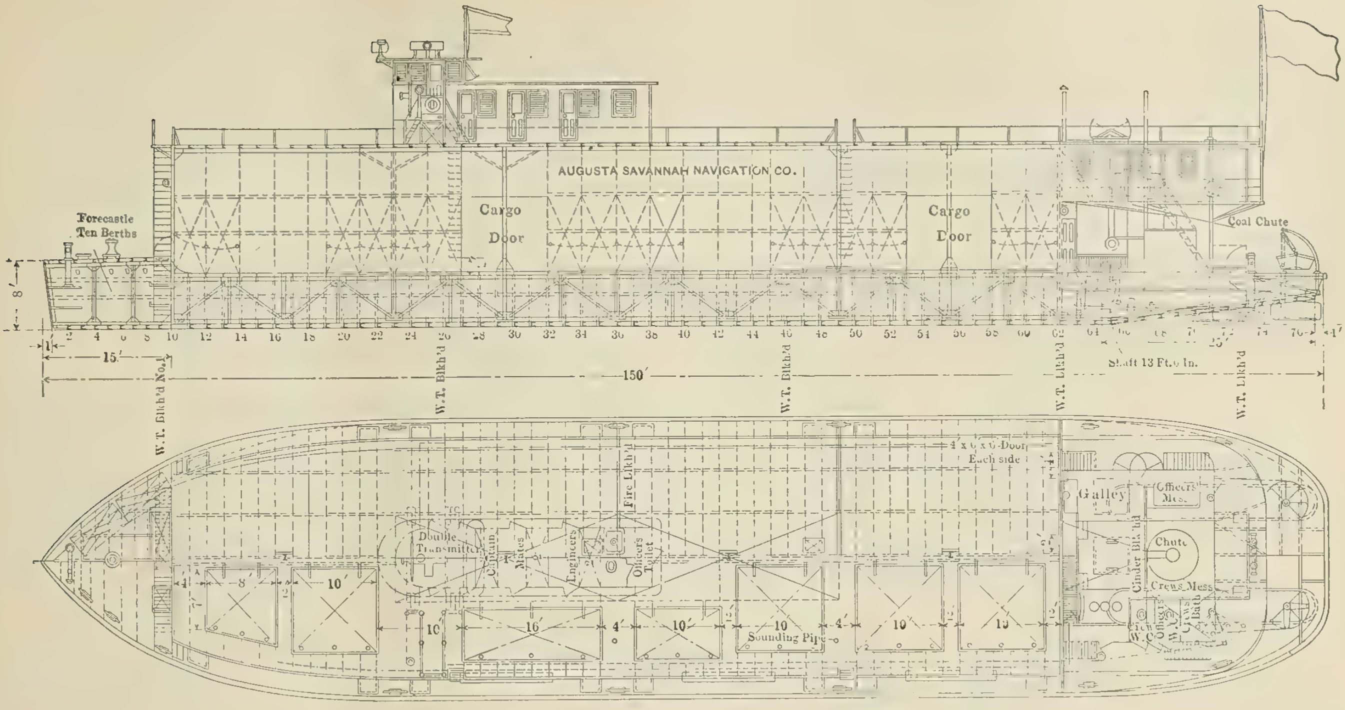


Fig. 3.—Inboard Profile, Half Plan and Half Section of Savannah Barge

double angle bars, and thus forming efficient side stringers.

Forward, a raised forecastle provides crew space, and closely spaced air-ports, with the large access hatch, will permit thorough ventilation. Access to the hold compartments is provided by bolted-plate hatches, as these compartments will not be used for cargo. Heavy towing and mooring bitts are fitted both forward and aft, and an American Engineering Company's capstan is mounted on the forecastle deck.

Each vessel will have four partly balanced rudders, two in each tunnel. Two large rudders are located just abaft the propellers, and two smaller rudders, intended principally to give control in backing, are located forward of the propellers. All four rudder stocks are linked together, and couplings are provided in the rudder stocks to permit a damaged rudder to be quickly replaced. Each boat will carry two spare rudders, one of each type.

Steel Cargo House

An interesting feature of the boats is the steel cargo house. This is 104 feet long, 26 feet wide and 15 feet high, with an athwartship bulkhead, or fire-wall, dividing it into two compartments. The framing consists of vertical steel angle bars, and a series of horizontal angle-bar purlines, to which the covering of heavy corrugated

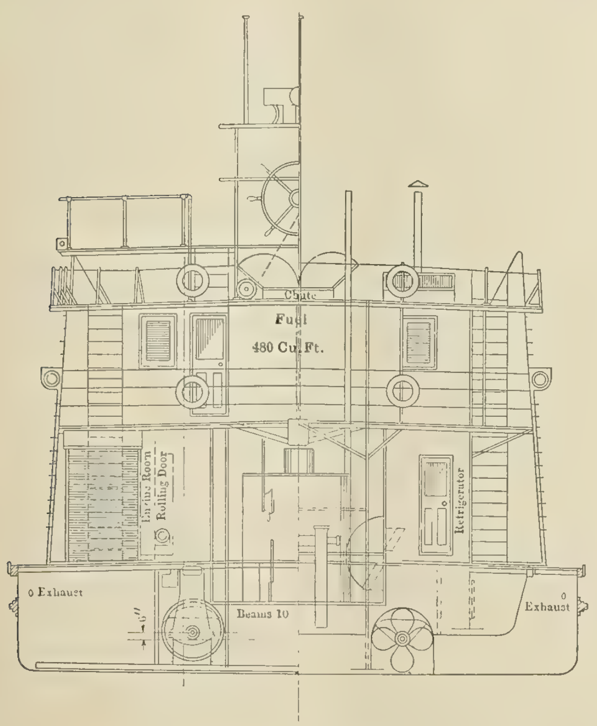


Fig. 4.—Section Through Machinery Space, Looking Forward

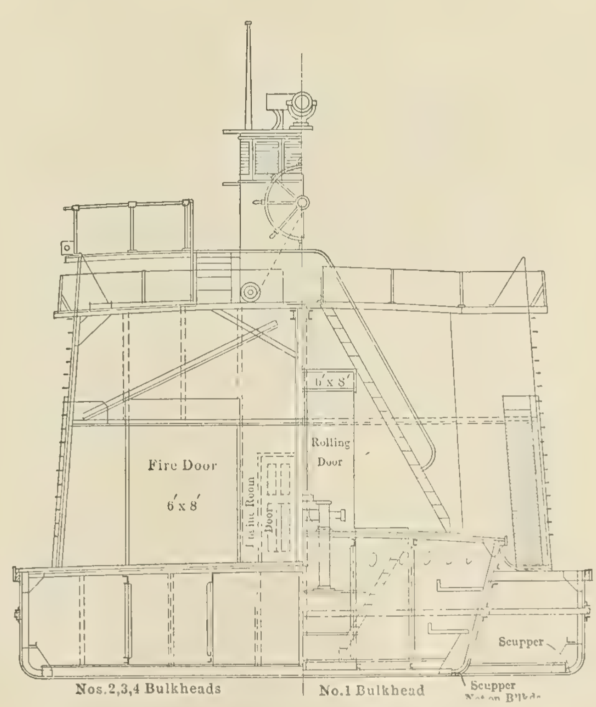


Fig. 5.—Section Through Cargo House, Looking Aft

galvanized metal is attached. Two large metal-covered cargo doors in each side of the house give access for stevedoring, and metal-covered doors are also provided in the ends of the house and in the fire-wall. The deck over the house is framed with 4-inch channel beams spaced 24 inches, and a double girder of 6-inch channels supports this deck on the center-line, this girder being upheld by the framing of the bulkheads and by bracketed pillars of 8-inch I-beams. The upper deck is plated with 3/16-inch steel, and practically the entire deck can be opened up for handling cargo over-all, by a series of large hatches with hinged-plate covers, also of 3/16-inch steel. An idea of the capacity of the cargo house may be obtained from the fact that it is capable of holding more than 1,200 bales of uncompressed cotton.

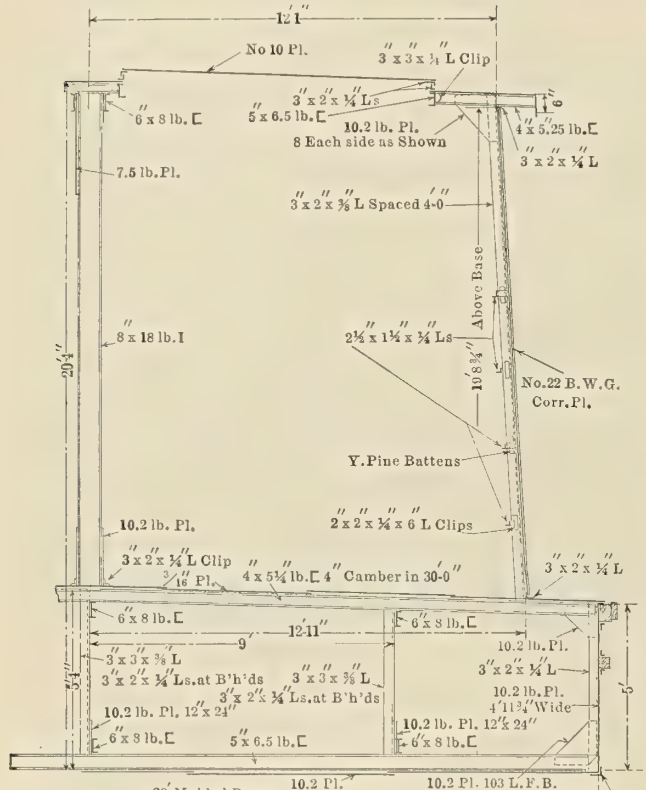


Fig. 6.—Midship Section, Showing Scantlings

The pilot house and a small Texas containing three staterooms, with officers' shower, lavatory and toilet space, surmount the cargo house, and, like it, are framed with steel and are housed in with corrugated galvanized metal. In conformity with the general fireproof design of the vessel, the doors, window frames, etc., of the quarters are of metal or metal-covered construction.

Abaft the cargo house are found the engine and producer rooms and coal bunker, engineers' and crew's toilets, crew's bath, the refrigerator and pantry, galley and messrooms, all these enclosures being entirely of metal construction.

Propelling Machinery

Each boat is propelled by twin screws driven by two 75-horsepower, three-cylinder Wolverine gas engines, furnished by the Wolverine Motor Works, of Bridgeport, Conn. The engines are of the most modern type, water cooled and with compressed air for starting, and the control and reverse levers are so arranged that both engines can be controlled from a central grating. The tail shaft is encased in a watertight tube so arranged as to provide forced lubrication for the stern and strut bearings. The propellers are three-bladed, of the built-up type, with provision for some adjustment of pitch, and each boat carries a pair of spare propellers, convenient hatches in the tunnels and deck permitting the ready replacement of an injured propeller.

The engines will be supplied with gas by a Galusha suction gas producer furnished by A. L. Galusha & Co., of Boston, Mass. Anthracite pea coal is used, and the arrangement provides a coal bunker above the engine room, from which the producer can be fired with a minimum of effort.

Fire Protection

An unusually large and powerful fire and bilge pump is installed in the engine room, with the object of providing fire protection very much above the average. Each pump is of 300 gallons capacity, Worthington, Class A, two-stage, and is mounted on a sliding base, permitting it to be driven off the port main engine by a friction drive, or off the starboard engine by a belt drive. The pump suction is taken from an athwartship supply main with intake through both sides of the vessel, and lever-operated gate valves are fitted in this cross pipe so that should the vessel be lying against the river bank the valve on that side can be closed to prevent sand being drawn in, the intake on the opposite side being of ample size for the pump suction. The engine circulation and producer pumps take their suctions from this same cross pipe, thus simplifying the outboard connections and giving all pumps the protection of the double gate valves.

The fire pump supplies a double main extending down each side of the cargo house, with fire plugs and attached hose so disposed that any point in the vessel can be reached with two streams at 100 pounds pressure from 50-foot lengths of hose with 1-inch nozzles, which is just double the requirements of the steamboat inspection laws. In addition, each boat will carry a full outfit of fire buckets and chemical fire extinguishers, and on the upper deck a portable chemical fire engine, with a 50-gallon tank and 50 feet of hose, will be carried on chocks, ready for instant service to any hatch or for landing in case of a wharf fire. This unusually elaborate fire-fighting equipment will secure low insurance rates on the cargo, and, what is even more important, will render anything but a small blaze in the cargo practically impossible, the boats themselves being non-inflammable.

The electric plant includes a 10-kilowatt generator, driven from the starboard main engine, a storage battery of ample capacity, with automatic charging switch, a powerful searchlight and an electric whistle, with the usual lighting circuits, outlets for portholes, etc. All wiring will be run in metal conduits and will conform to underwriters' rules.

The plumbing is of higher class than is ordinarily to be found on river boats, and includes shower baths for officers and crew. The fresh-water supply is carried in a large tank in the hold, and is distributed by means of an air pressure of 30 pounds, derived from the engine compressed-air tanks. A hot-water heating system is provided for heating the pilot house, messrooms and staterooms, with an American Ideal hot-water heater located in the engine room.

Cargo-Handling Machinery

For handling cargo at the Augusta terminal, main reliance is placed on the terminal appliances, but for use at other landings and also for auxiliary use at Augusta, each vessel is equipped with two power-driven cargo winches furnished by the National Hoisting Engine Company, of Harrison, N. J., through the Austin Machinery

Company, of Atlanta. These winches are mounted on the upper deck, forward and aft, and are geared to a longitudinal shaft carried just under the deck, which in turn is belt driven from the port main engine. Each boat carries two portable cargo derricks of a special type not unlike the United States Navy coaling booms, and of 2,000 pounds capacity each. Convenient step fittings are provided for using these derricks to plumb the hatches on either side of the vessel.

Knock-Down Construction

The contract for the two boats was awarded on May 1 to the Racine-Truscott Shell Lake Boat Company. The steel work was fabricated at that company's shipyard in Muskegon, Mich., in record time, the boats being loaded on cars consigned to Savannah by August 1, after having been erected and bolted together and then knocked down at Muskegon.

The work of erection at Savannah has progressed rapidly, and it is expected that the trials will be run early in December.

Augusta Terminal

In the design of the Augusta terminal, which is being built by the city primarily for the use of the new Navigation Company, every effort has been made to provide wharfage facilities which would enable the freight to be handled rapidly, safely and economically, it being realized that in low stevedoring costs lay an all-important element of success. The problem was rendered somewhat difficult by the fact that the flood stage of the river had to be taken into account as a controlling feature of the design, and to insure safety to the freight and freedom from interference with the operation of the boats and terminal, the wharf deck and warehouse floor were put several feet above the highest recorded water level, or about 30 feet above the ordinary surface of the river.

To minimize the fire risk, the wharf deck and warehouse floor are reinforced concrete, and the warehouse is carried on concrete piles, the remainder of the structure being supported by heavy wooden piling treated with a preservative and so arranged that the piles may be replaced eventually by concrete as renewal becomes necessary. The wharf has a total length of 300 feet along the river, and the warehouse, of corrugated metal on a steel frame, is 200 feet by 60 feet, with a height under the eaves of 20 feet.

Between the warehouse and the string piece of the wharf an electrically operated locomotive "Brownhoist" crane will run on an 8-foot track parallel to the river, and will provide the principal means for overcoming the 30-foot lift made necessary by the height of the wharf above the ordinary stage of the river. This hoist will operate directly through the large cargo hatches in the upper deck of the boats, and will deposit on the wharf or on the electric storage-battery trucks, of which two will be provided.

As a further provision for overcoming the 30-foot lift, arrangements are being perfected for running the electric trucks down to the boats by means of either inclined or vertical elevators, so arranged that all stages of the river will be provided for. At ordinary stages of the river a paved wagonway will also be available for direct teaming to and from the boats.

For rapid loading, both the crane and the electric trucks will be available, and in addition there will be package chutes for use with all kinds of freight for which this method is suitable, including baled goods, cased goods, etc.

On the land side of the warehouse will be laid the siding connecting with all the railways entering Augusta, and making it possible to switch a car to any warehouse or factory having track connections. The lay-out provides for a three-track switching yard, although only one track will be laid at first. A short spur will be run out onto the wharf, where it can be reached by the locomotive crane, making it possible to load a flat car directly from the boats, and under this spur a coal storage bin can be provided for producer coal, when needed, so arranged that the boats can be coaled by gravity, the coal being dumped from the cars into the bin and from the bin into the bunkers without any handling.

With the arrangements described it will be possible to handle freight with great rapidity, both in discharging and in loading, with correspondingly low stevedoring costs and with the further advantages of quick delivery to consignees and short tie-up periods for the boats.

Twin Tandem Screw Light Draft Steamers for Russia

Early in July Messrs. John I. Thornycroft & Co., Ltd., shipped from Southampton two interesting shallow-draft boats for the Department of Ways and Communications to Russia, the order being completed within ten weeks from its receipt. Fig. 1 shows the vessels under construction in Messrs. Thornycroft's yard. They were subsequently dismantled and shipped for re-erection at Tiumen, on a tributary of the river Ob, Siberia. Their dimensions are:

Fig. 1

Length on waterline	90 feet
Beam molded	15 feet
Depth	5 feet
Draft in service condition	2 feet 1½ inches

The hull is built with twin-tandem screw tunnels, and is of mild steel plates and angles of light scantlings, and divided into four watertight compartments. The fore peak is fitted as a chain locker, and abaft is placed under a coach roof the crew space, with berths for four men.

The amidships compartment contains the machinery, consisting of two sets of compound-jet condensing engines, giving a total of 130 horsepower at 280 revolutions. The cylinders are 6¾ and 13½ inches diameter, with 8½ inches stroke.

Steam is supplied by a navy type boiler, 5 feet 8 inches diameter by 12 feet 4 inches long, burning coal and working under natural draft at a pressure of 140 pounds per square inch.

The after compartment is fitted as a saloon, with coach roof over, and contains sofa berths for six officials. The after peak is arranged as a small hold. The vessels are steered by a hand-steering gear placed on the coach roof forward, and connected to a large area balanced rudder. A towing hook is fitted on the casing aft, and a small hand-windlass forward for working the cables.

Review of United States Army Engineers' Report on Experimental Towboats

BY H. MCL. HARDING*

In accordance with the River and Harbor Act of June 25, 1910, an appropriation of $500,000 (£102,500) was made by Congress for the construction of two towboats, together with a complement of suitable barges and necessary loading and unloading facilities, such as are required on the Mississippi River. The appropriation also covered an extensive investigation of the types of boats in use for similar purposes on non-tidal rivers in the United States and in foreign countries.

The Commission of United States Army Engineers appointed to carry out this investigation, and make the necessary experiments, has now completed its work, and the results have been printed by the Government. The work required four years for completion, and included a trip abroad for the investigation of river navigation in Europe. The printed report discusses the various methods of river transportation, experiments upon model towboats and barges, experiments on paddle wheels, and also a consideration of cargo-handling appliances. No report has been issued by the Federal Government for many years which has such a direct value as this report, and Colonel Lansing H. Beach, Lieutenant Colonel H. C. Newcomer, Lieutenant Colonel Charles L. Potter and Lieutenant Colonel C. Keller are to be congratulated and thanked for the valuable information they have collected and so forcibly presented.

The committee, which conducted the investigation in Europe, brought back many new facts based upon keen and practical observation of types of river boats and methods of operation. The committee visited previously unreported fields and described the tugs and barges on such rivers as the Molden, Danube and Saone, as well as the craft on the rivers of Germany, Belgium and Holland. Data were also collected at European shipbuilding plants regarding the construction and operation of shallow-draft boats for use on the swift rivers of Africa and India.

The report answers fully the following questions, which so often occur to those who are engaged in or are about to engage in river transportation. The results are confirmed by the most careful studies and by experiments by experts.

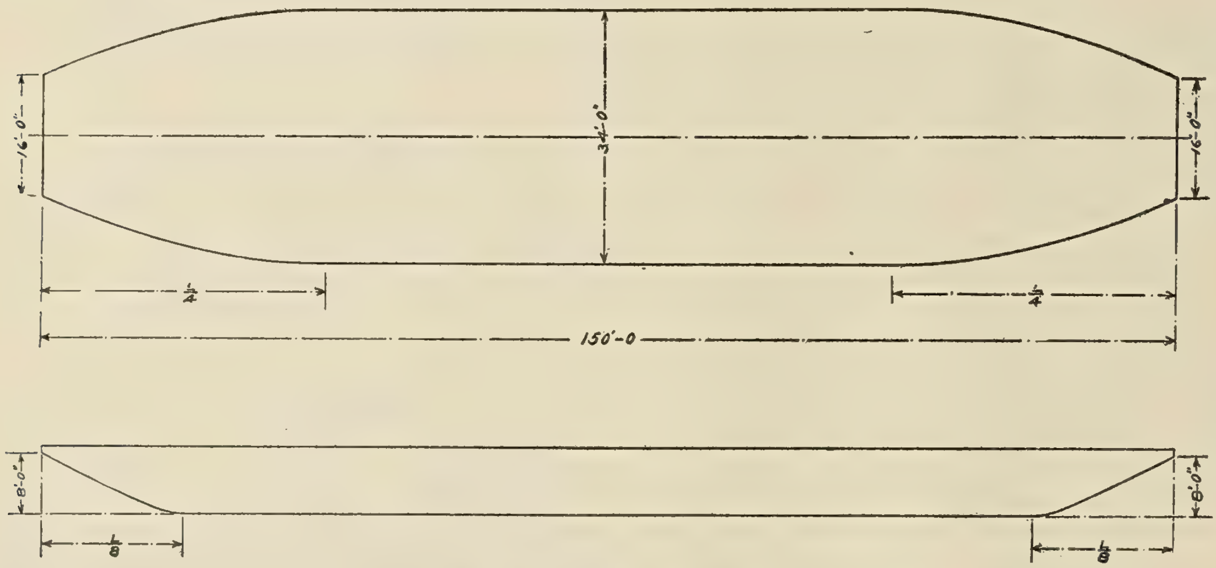


Fig. 1.—Decked Type of Barge

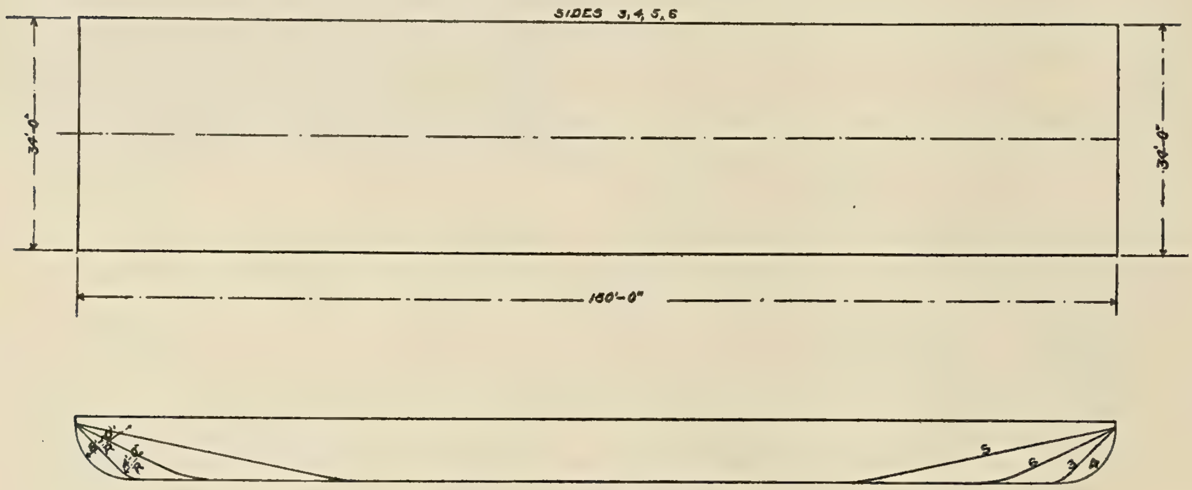


Fig. 2.—Open Type of Barge

1. What should be the design of the barge, its length, width, material and capacity?

* Consulting Engineer, Marine Terminals, New York.

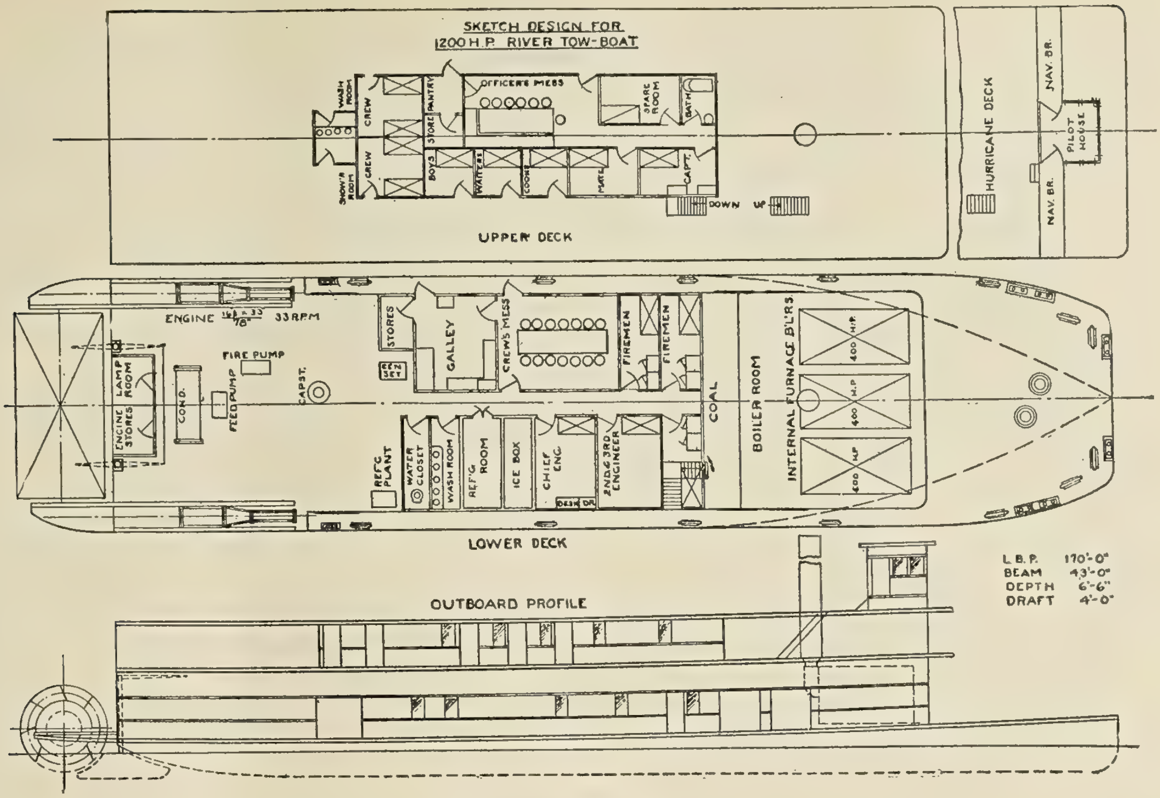


Fig. 3.—Stern-Wheel Towboat

2. How many barges should there be in a tow, and what should be the relative formation of the tow?

3. What should be the design of the towboat, its length, width and draft?

4. What are the most practical types of engines and boilers; what horsepower is required? Should the side-wheel, stern-wheel or tunnel-screw propeller be used? If stern-wheels are used, should they be of the feathering or radial type? What is the most efficient diameter for the wheel?

Recommendations

A summary of the board's recommendations follows:

1. The adoption of the types of barges shown in Figs. 1 and 2 and the construction of six of each of the barges. The decked barges, Fig. 1, are 150 feet long, 34 feet beam; the open barges, Fig. 2, are 150 feet long, 34 feet beam,

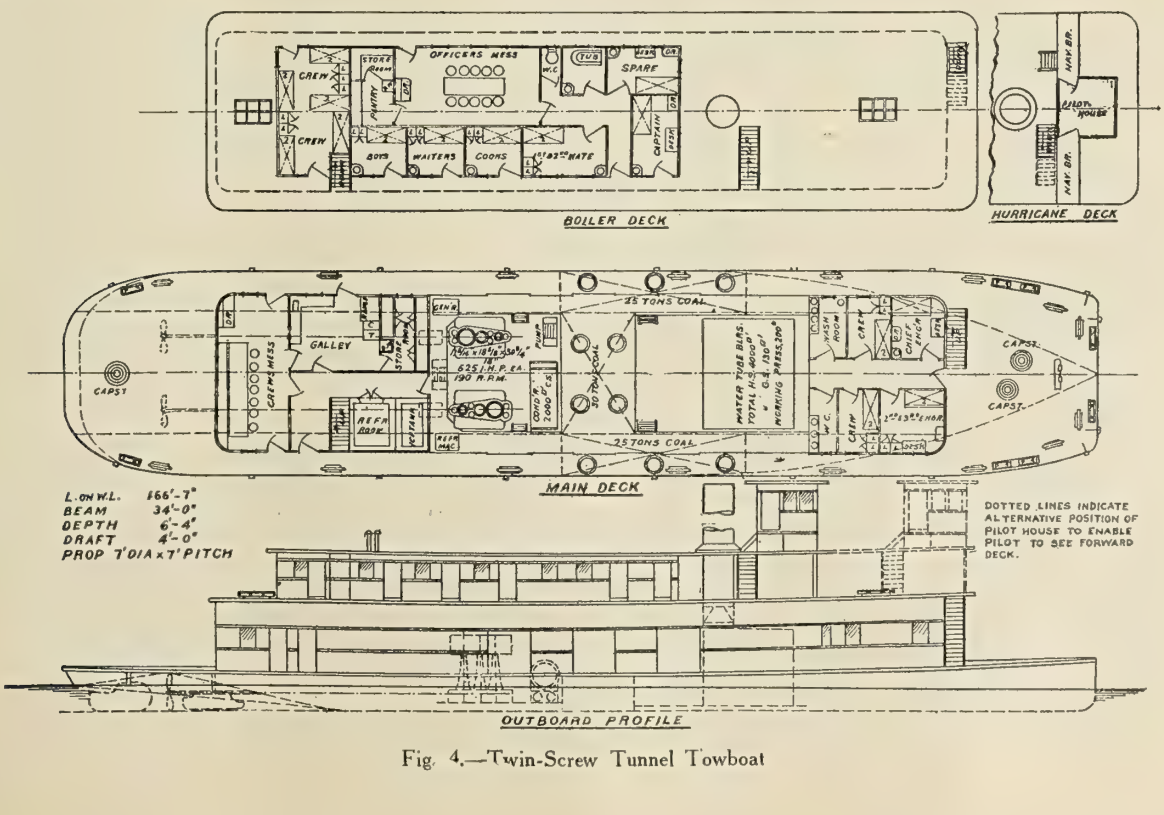


Fig. 4.—Twin-Screw Tunnel Towboat

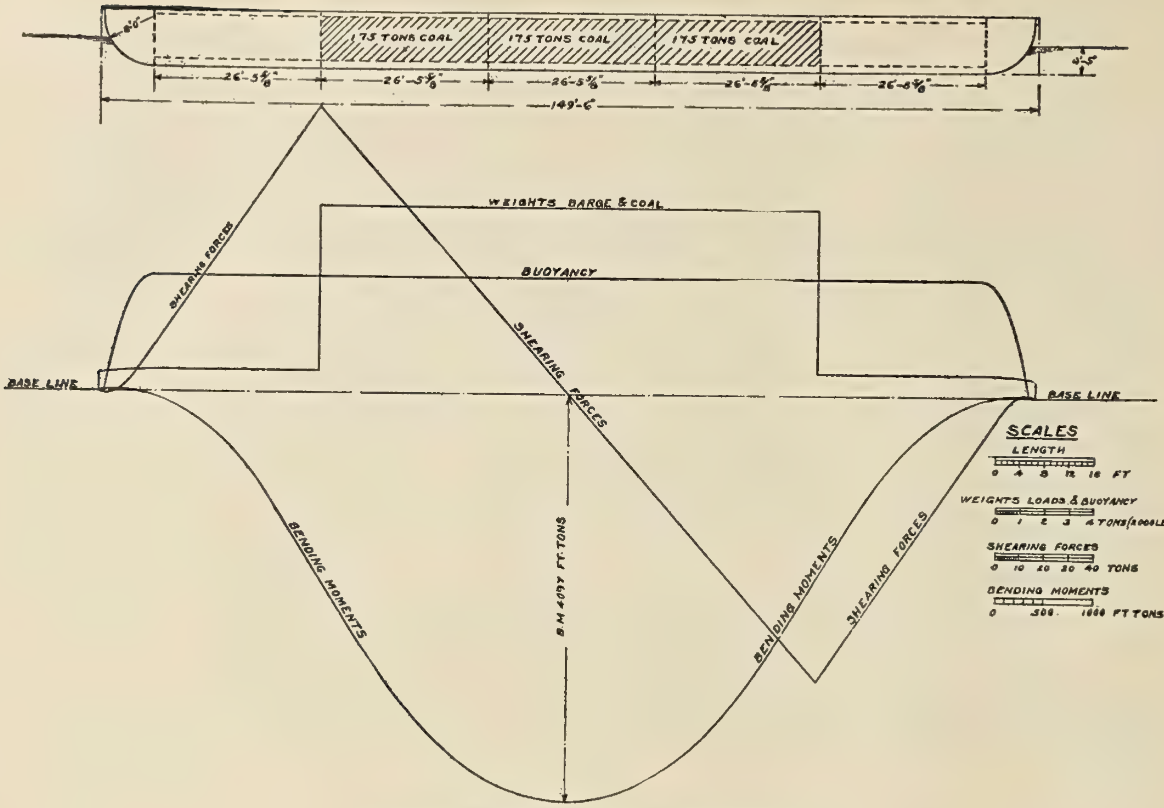


Fig. 5.—Shearing Forces and Bending Moments

weighing 45 short tons, with a carrying capacity of 880 short tons.

2. The construction of two towboats, one of the stern-wheel type with feathering wheel, Fig. 3, and one of the twin-screw tunnel type, Fig. 4. The stern-wheel towboat has a beam of 43 feet, a draft of 4 feet, and engines of 1,200 indicated horsepower. The twin-screw tunnel boat has a beam of 34 feet, a length between perpendiculars of 170 feet and a draft of 4 feet.

3. The boilers of the stern-wheel boats shall be of the

ESTIMATED WEIGHTS AND COSTS OF A 1000 I.H.P. RIVER TOWBOAT INSTALLATION (EXCL. ALL AUX. EXCEPT CONDENSING PLANT) WITH VARIOUS TYPES OF MACHINERY AT 180# BLR. PRESS.

	ENGINES					BOILERS								CONDENSER		ENTIRE PLANT		
	TYPE	PISTON SPEED F.P.M.	WEIGHT LBS.	COST $	STEAM PER HR LBS	TYPE	TOTAL H.S. ☐'	TOTAL G.S. ☐'	WEIGHT EMPTY LBS.	WT. OF WATER LBS.	WT. BLR. & WTR LBS.	COST $	WEIGHT LBS.	COST $	TOTAL WT. (INC. WTR) LBS.	TOTAL COST $	COAL PER HR LBS.
LONG STROKE	SIMPLE, NON-CON.	200-225	72000	9000	33000	FLUE	4200	140	235,000	75000	310000	10290			382000	19290	3830
	COMP., COND'G	200-250	128000	12,800	20000	"	2500	83	140000	46000	186000	6125	35000	3500	348000	22425	2320
	" "	" "	"	"	"	SCOTCH	3000	100	133500	66500	200000	13300	"	"	363000	29600	2250
	" "	" "	"	"	"	WARD'S STR. T.	4500	104	80000	11250	91250	12350	"	"	254250	28650	"
	" "	" "	"	"	"	B&W.	4500	112	131000	32000	163000	13600	"	"	326000	29900	"
	TRIPLE, COND'G	400	200000	20,000	16000	FLUE	2000	67	112000	37000	149000	4900	"	"	384000	28400	2100
	" "	"	"	"	"	SCOTCH	2400	80	106800	53400	160200	10660	"	"	395200	34160	1800
	" "	"	"	"	"	WARD'S STR. T.	4000	91	70000	10000	80000	11000	"	"	315000	34500	"
	" "	"	"	"	"	B&W.	3600	90	104000	25600	129600	10900	"	"	364600	34400	"
SHORT STROKE	WARD, 1CR'K, T.EX.	600	28000	11000	"												
	" ,3 " , " "	"	30600	11000	"	WARD'S STR. T	4000	91	70000	10000	80000	11000	"	"	145600	25500	"
	ORDINARY, VERTICAL TR. EXP.	"	150000	15000	"	WARD'S STR. T.	4000	91	"	"	"	"	"	"	265000	28500	"
	ORD. VERT. COMP.	"	100000	12500	20000	"	4500	104	80000	11250	91250	12350	"	"	226250	28350	2250
	DIESEL (OIL)		120000	81000											120000	81000	(OIL) 500

COMPARATIVE YEARLY ECONOMIES OF THE ABOVE TYPES OF INSTALLATION.
FIXED CHARGES 18% ON INVESTMENT.
OPERATING TIME 300 DAYS OF 12 HRS.
COST OF COAL, $3.00 PER SHORT TON.

	TYPE OF ENG.	TYPE OF BLR.	FIXED CHARGES	COST OF FUEL	F. C. + FUEL
LONG STROKE	SIMPLE, N.C., 200 F.	FLUE	$3472	$20700	$24172
	COMP. COND. 225 F.	"	4036	12500	16536
	" " "	SCOTCH MARINE	5328	12150	17478
	" " "	WARD'S STR. T.	5157	12150	17307
	" " "	B&W., W.T.	5382	12150	17532
	TRIPLE, " 400 F.	FLUE	5112	11340	16452
	" " "	SCOTCH MARINE	6149	9720	15869
	" " "	WARD'S STR. T.	6210	9720	15930
	" " "	B&W., W.T.	6192	9720	15912
SHORT STROKE	WARD, 3CR., T. EXP.	WARD'S STR. T.	4590	9720	14310
	ORD., VERT. T. EXP.	WARD'S STR. T.	5310	9720	15030
	ORD., VERT. COMP.	" " "	5103	12150	17253
	DIESEL (OIL)	(OIL @ $1.00 per BBL.)	14580	5715	20295

NOTE:
IN THE CASE OF ITEMS # 1 & 2 (SIMPLE, NON-COND., AND COMP. COND., LONG STROKE) THE EFFECT OF DOUBLING THE PISTON SPEED IS TO REDUCE THE WEIGHT AND COST OF ENGINE BY ABOUT 40%.

THE AUTHORITIES FOR WEIGHTS & COST OF THE ABOVE LONG STROKE ENGINES ARE.
JAS. REES, SONS & CO.
PITTSBURGH.
GILLETT, EATON & SQUIRES
LAKE CITY, MINN.

NOTE.
THE BONSON BOILER IS OF ABOUT THE SAME WEIGHT PER ☐' OF H.S. AS THE BABCOCK & WILCOX SEMI-MARINE QUOTED ABOVE, AND ABOUT 15% CHEAPER ON THE SAME UNIT.
TWO "HEINE" SEMI-MARINE BOILERS WITH A TOTAL H.S. OF 4884 SQ. FT., WEIGH (WITH WATER) 222000 LBS. AND COST $9000.

Fig. 6.—Table of Estimated Weights and Costs of 1,000 Indicated Horsepower Towboat

internally-fired retuhn-tube type or the combination fire and watertube type with straight tubes, the engine being of the tandem compound condensing or similar type.

4. The tunnel design boat shall be provided with sectional propellers made of cast steel. In the case of steam propulsion the boiler shall be of the combination type, or watertube type, with straight tubes, and the engines of the triple-expansion type, or in place of steam power internal combustion engines may be used with gas producers.

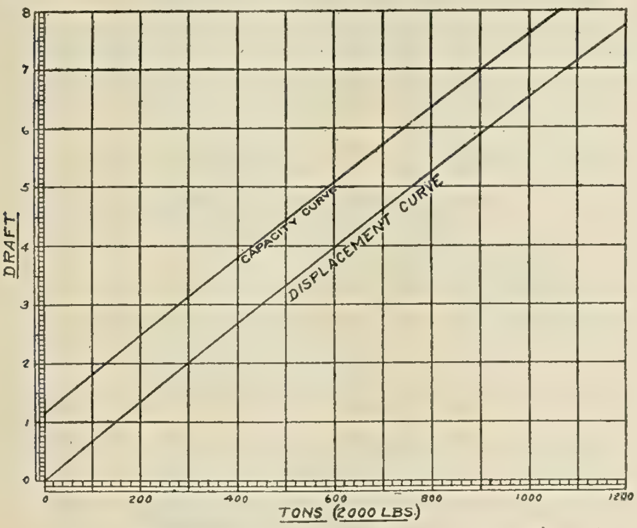


Fig. 7.—Displacement and Capacity Curves, Barge No. 4 (See Fig. 9)

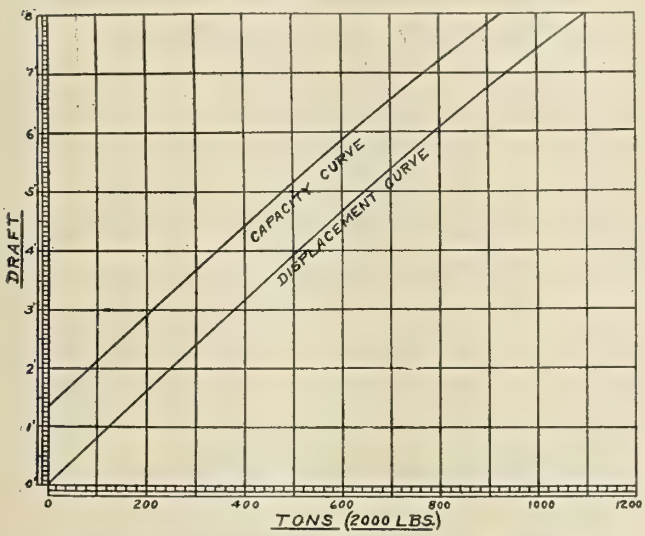


Fig. 8.—Displacement and Capacity Curves, Barge No. 2 (See Fig. 9)

Among the many valuable deductions given in the report resulting from the studies and investigations made the following are noteworthy:

Economical Speed for Upstream Towing

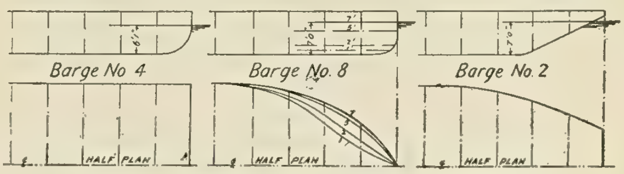
The economical speed for upstream towing is 50 percent greater than the velocity of the stream. If the speed of the current at low water is found to be 3.5 miles per hour on the lower Mississippi, the most economical still-water speed from the point of view of power required is 5.25 miles per hour.

To compare the power required to tow a fleet of six barges with that required for a single barge of the design recommended at the speed of 5.25 miles per hour, it was found that at full-load displacement in 9 feet of water the fleet of six barges developed only 3.5 pounds resistance per short ton of displacement, as against 4.75 pounds for the single barge, making a saving of about 25 percent for the fleet formation. This may be accounted for to some extent by the fact that the fleet, when lashed rigidly together, is practically a large barge. At the same displacement and in the same depth of water, the resistances per ton of displacement for the same barge, when towed in groups of 2, 3, 4 and 5, at 5.25 miles per hour, are respectively 12.5 pounds, 5.85 pounds, 5.4 pounds and 3.65 pounds. With more than one barge the obvious advisability of increasing the number of barges in a tow to the greatest permissible limit is confirmed by the above figures.

Cost of Freight Transportation in various forms of Barges and at various speeds and depths

Per cent of total investment for fixed charges - 18%
Investment per ton of capacity. Barges - $15 00
Investment per I H P in Towboat - $100 00
Cost of Coal per ton (2000 lbs.) - $3.00 Towing hrs, Yr (300 × 12) = 3600
Coal consumption per I H P. - 2¼ lbs Wages & subsistence, Yr - $20,000
T-R. H.P derived from model basin experiments on Fleets of five & six barges lashed together, 3 long & 2 wide $\frac{\text{Towrope H.P.}}{\text{I H P.}} = 30\%$

No. of Barges	Total displ.	Total cap'y	Barge No.	Miles per Hr	Towrope H P	I H P	Per ton mile: lbs of Coal	Cost of Coal $	Wages & Subsistence $	Fixed Charges $	Total cost of Transport'n. $
							in 9 ft of water				
Six	5600 short Tons	4500 short Tons	2	7	695	2317	166	.000249	.000177	.000472	000898
				6	416	1386	115	000172	.000206	.000382	000760
				5	240	800	080	000120	000247	.000328	000695
			4	7	845	2817	201	.000302	.000177	000554	.001033
				6	475	1583	.132	000201	.000206	000417	000824
				5	246	820	.082	.000123	.000247	.000332	.000702
			8	7	860	2867	.205	.000307	000177	.000562	.001046
				6	480	1600	.133	.000200	.000206	.000421	.000827
				5	258	860	.086	.000129	.000247	.000341	.000717
							in 12 ft of water				
			2	7	673	2243	160	.000240	.000177	.000463	.000880
				6	400	1333	111	.000167	.000206	.000372	000745
				5	227	757	076	.000114	.000247	000324	.000685
			4	7	684	2280	163	000245	.000177	.000470	.000892
				6	416	1387	.115	.000172	.000206	.000382	.000760
				5	228	760	076	.000114	.000247	.000319	.000680
			8	7	579	1930	138	.000207	.000177	000413	.000797
				6	320	1067	.089	.000134	.000206	000322	.000662
				5	173	573	.057	.000085	.000247	.000282	.000614
							in 9 ft. of water				
Five	4660 s. Tons	3750 s Tons	2	6	299	997	.099	.000149	.000247	.000346	000742
				5	205	683	082	000123	.000296	000332	.000751
			4	6	280	933	093	.000140	.000247	000332	000719
				5	205	683	.082	.000123	.000296	.000332	.000751
			8	6	270	900	.090	.000135	.000247	.000325	.000707
				5	180	600	.072	.000108	.000296	000310	.000714



All Barges are 150'0" × 34'0". 932 short tons displacement. Bow & Stern identical.

Fig. 9.—Table of Transportation Costs

Material for Barges

Taking into consideration the first cost, repairs, length of life and frictional resistance, the steel barge, though costing more than twice as much as a wooden barge ($6,000 for wood and $13,000 for steel), is the more economical in the end.

A committee of the engineers traversed portions of the principal rivers of Germany, Belgium, Holland, Austria and France, and first investigated and considered types of boats in use for similar river purposes; then visited the principal boat and engine-building plants of these countries and Great Britain, and also inspected the loading and unloading appliances in the principal harbors of these countries. The report justifies the conclusion—

1. That towing by European methods is not suitable on the Mississippi River and its tributaries.

2. That, while several features of the towboats on the

European rivers are worthy of consideration, towing by towline is not considered practical upon our Western rivers on account of the physical conditions and the necessity of having a crew on each barge.

3. Most compound or triple-expansion engines, with superheated steam and feathering wheels and possibly Diesel engines, give good results.

4. That the choice of towboats is limited to three types —the side-wheel, stern-wheel and tunnel propeller.

The side-wheel boat is the predominant type on European rivers. This is doubtless due to the method generally adopted there of towing the fleet astern of the towboat, which, as stated above, is not applicable to our Western rivers.

In American practice on shallow rivers the principal function of the towboat in downstream traffic is to control the movement of the tow in passing bends by flanking. By reason of the large balanced rudders used on the stern-wheel boats, these can develop much more flanking power when backing than it is possible to obtain with the side-wheel boat. This consideration was believed by the engineers to be of sufficient importance to eliminate the side-wheel boat for towing purposes upon our Western rivers. It is stated in the report that the tunnel propeller boat has been successfully used when towing astern the same as the stern-wheel type.

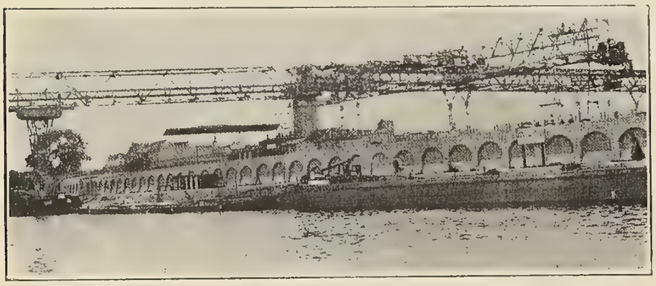


Fig. 10.—Unloading Plant at Storage Yard, Berlin, Germany

After many experiments to determine the best type of towboat, it was found that a boat 43 feet wide and 4 feet draft, fitted with a stern wheel 14.6 feet in diameter, having 10 blades, the depth of immersion being 3 feet 6 inches, gave the best results. Many tables are given as to thrust, immersion, diameter of wheel, dimension formulæ, slip, efficiency for different-sized wheels of both the radial and feathering types, with many comparisons. The tables of the results of boiler tests being made by the Mississippi River Commission from boats in operation are of special value.

The designs of the barges adopted are shown in Figs. 1 and 2, Fig. 1 being for the decked and Fig. 2 for the open barge. Fig. 3 shows the stern-wheel towboat design and Fig. 4 the tunnel-propeller towboat design.

The tables of curves of displacement, of which there are some forty-eight in the report, will well repay careful study, as well as the many other plotted curves, showing at different depths of water the effects of different numbers of barges in total resistance both with the barges empty and partially or wholly loaded, and also in different arrangements of formation; also the curves of steering experiments and of thrust, torque and efficiency, immersion and rudder moments. The curves of maximum transverse and longitudinal bending moments for the types of barges selected are of great interest. There is a table of the estimated weights and costs of a 1,000-horsepower river installation of various types of machinery, with fixed charges of operation and the cost of fuel.

Within the past few years since it has become evident that the disinterested efforts of such men as Hon. Thomas Wilkinson of Burlington, Iowa, president of the Upper Mississippi Improvement Association, have borne fruit, and that profitable Mississippi river transportation is becoming an accepted fact, many different types of barges have been tried out on the river, but much of the difficulty in selecting the proper equipment for such work will be overcome by a careful study of a part of the Government engineers' report, which has been prepared by Professor Herbert C. Sadler, professor of naval architecture

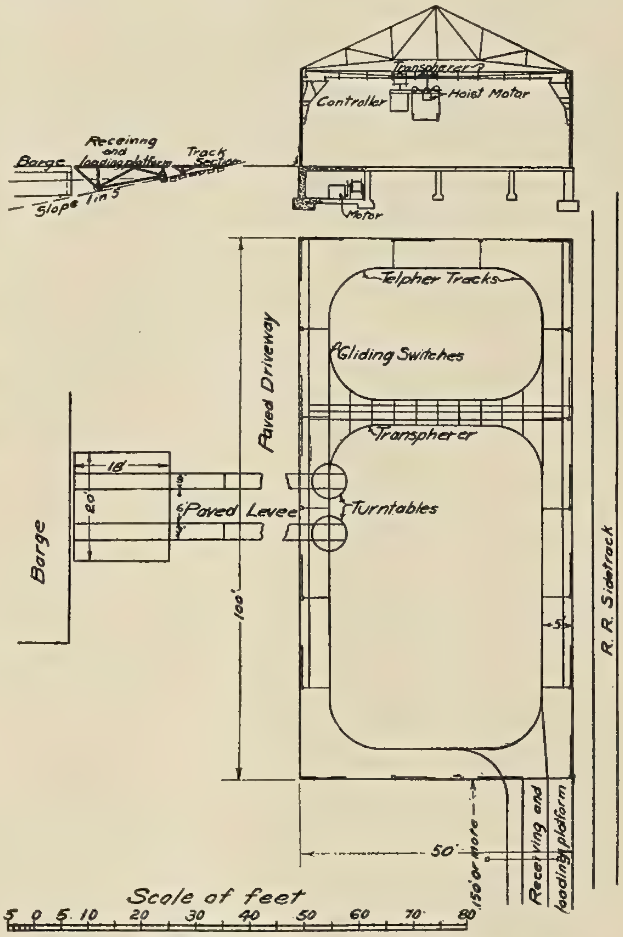


Fig. 11.—Outline Plan of Proposed River Terminal

and marine engineering, at the University of Michigan, dealing with barge and towboat forms and tests. There is no doubt but that Professor Sadler's advice as to the types of power boats, or barges, for any particular kind of freight service on either shallow or deep rivers will be of great value and assistance.

At the end of the complete report there is a description of an excellent type of river boat now operating on the Black Warrior River, designed by John H. Bernhard of New Orleans, and which will probably be used extensively on all of the Western rivers and Eastern canals.

Another portion of the report which is of interest discusses the handling of freight. Based on experience abroad, it is evident that in loading and unloading barges there should be vertical movements coupled with the use of the horizontal overhead conveyors.

M. E. B. A. No. 33 Annual Entertainment.—The annual entertainment and ball of the M. E. B. A. No. 33 will be held on Wednesday evening, December 2, at the Lexington Avenue Opera House, Fifty-eighth street near Third avenue, New York City.

The Towboat Industry on Western Rivers

Government Projects for River Improvement—Cost of Towing on Long and Short Hauls—Growth of the Towing Industry

BY M. VON PAGENHARDT *

During the last decade, navigation on the western rivers of the United States has undergone a complete change. The once predominant packet boat transporting passengers and miscellaneous freight at comparatively high rates has practically disappeared in the face of railroad competition. On the other hand, the towing business has developed from common rafting to a most substantial and important industry.

River Commerce 1912-1913

During the calendar year July, 1912, to June, 1913, commerce on the Ohio and Mississippi rivers amounted to 10,714,383 tons, with a valuation of $111,562,879 (£22,850,000). Seventy percent of this consisted of towing business, while, in addition, on the Ohio River 3,832,289 passengers were carried, although a very large percentage of this business was due to local excursion trade.

If to the above are added the extensive Monongahela River coal trade, amounting to several million tons a year, the Missouri River trade with its growing merchandise movement, and the rapidly increasing coal trade on the Alabama rivers, it is not astonishing to see the generous appropriations of the Federal Government expended for the benefit of navigation on the western rivers.

Government Projects

The year 1910 marks the turning point in the systematic development of the western rivers. By act of Congress the following projects were adopted:

A 9-foot channel in the Ohio, to be completed in twelve years. An 8-foot channel in the Mississippi from Cairo to the mouth of the Missouri River, to be completed in twelve years. A 6-foot channel in the Mississippi from St. Louis to Minneapolis, to be completed in twelve years. A 6-foot channel from Kansas City to the mouth of the Missouri River, to be completed in ten years. A 9-foot channel from Cairo to New Orleans, the time of completion indefinite.

At the present time, in the Mississippi River between St. Louis and New Orleans, there is an 8-foot channel at the lowest stage of water. On the Ohio project, which comprises fifty-four locks and dams, twelve are now finished and under operation. One dam, No. 26, was completed but was carried away by high water in 1912, and will be repaired this year. Nine others are nearing completion, while the contracts have been let for seven more, leaving twenty-five others still to be undertaken. Even now, however, a channel depth of 4 feet is available at the lowest stage of water. On the Mississippi River the work between Cairo and St. Louis is 30 percent completed; the work on the upper river, 40 percent complete; the work on the Missouri River, 15 percent complete; the work on the Tombigbee and Warrior rivers in Alabama, 87 percent complete, while the work on the lower Monongahela River has been finished.

Results of River Improvement

The extent to which such improvements aid the navigation interests is shown by the following figures which a prominent coal firm operating on the improved Monongahela River courteously gave to the writer. This company, with a fleet of five 500-horsepower towboats and 100 barges, transports coal from a point 65 miles above Pittsburg down the Monongahela River to Pittsburg. The actual cost of transportation per ton varies between 4 and 5 cents (2 to 2½d.), as is shown in the following figures:

Yearly Expenses of a 500-Horsepower Towboat

Wages	$11,000	(£2,260)
Repairs	1,500	(308)
Fuel	6,000	(1,230)
Lubrication	1,500	(308)
Commissary	3,500	(718)
Insurance	540	(111)
Tonnage	600,000	
Cost per ton	4 cents	(2d.)

To this might be added the cost of loading and unloading the barges. The loading, however, is done very cheaply, as the coal mines are situated close to the river and the mining cars coming from the mines run out over the barges, where they are automatically unloaded. The cost of loading is, therefore reduced to less than ½ cent (¼d.) per ton.

The cost of unloading the barges is given as 3 cents (1½d.) per ton, which is a remarkably low figure. The unloading is done by means of a continuous chain elevator with a capacity of 5 cubic yards per bucket and an unloading capacity of 500 tons per hour. The coal is delivered on to a belt conveyor having a running speed of 20 feet per second, conveying the coal to hoppers above the coke ovens.

To the above costs there must be added the depreciation and interest on the total investment, which is estimated at $1,500,000 (£308,000) for a yearly capacity of 3,000,000 tons. Allowing 10 percent for depreciation and 5 percent for interest, the sum of $225,000 (£46,200), or 7.4 cents (3.7d.) per ton (which is double the cost of transporting or conveying the coal) must be added, bringing the total cost per ton, including overhead expense, to about 15 cents (7½d.) per ton, or 2.3 mills per ton mile. The railroad rate between the same points is 45 cents (1/10½) per ton, or three times the amount by water, and it might be added that the railroad could not handle the same daily tonnage as is handled on the water.

Cost of Operation

Investigation of the operating details of such towboats and barges shows that the crew of each towboat consists of fourteen men; that is, one master, one pilot, one engineer, one assistant engineer, two firemen, a cook and helper, and six deckhands.

The repair bill of $1,500 (£308) per year, given in the table above, is due chiefly to boiler trouble. From 60 to 75 percent of the repair bill is accounted for by repairs to boilers, while the remainder is accounted for by repairs to the wheels made necessary by the heavy pounding of the wheels through ice in winter time. The boiler repairs consist principally of replacing burned sheets. The type of boiler used is the externally-fired, return flue boiler with flues of large diameter in a shell of about 42 inches diameter and 28 feet length. Ordinarily three of these boilers

* Naval Architect, Kansas City Missouri River Navigation Company, Kansas City, Mo.

are mounted over a common furnace, and, although they are reliable steamers, allowing a high rate of forcing, they are, nevertheless, subject to breakdowns due to burned sheets.

The lubrication bill, given above, seems unnecessarily high, while the fuel bill of $6,000 (£1,230) per year figured on a consumption of 6,000 tons of coal per year at $1 (4/2) per ton, is remarkably low. The cheapness of the coal is, of course, due to the nearness of the coal fields and to the fact that the mines are owned by the company. But even considering this relationship of the common ownership of the boats and the coal fields, the coal consumption of 6,000 tons per year is remarkably low for western river conditions, and can be explained only by the down-stream movement of this coal. Each towboat has to make in the neighborhood of 240 round trips per year, each trip averaging thirty-six hours, to move 600,000 tons of coal per year. Each towboat, however, cannot consume more than 25 tons in thirty-six hours, or 3 pounds per horsepower hour, which is a rarely attained fuel economy on western rivers. This means that 2,500 tons of coal or freight are moved on the river with a fuel consumption of ¾ ton per hour, while on the Great Lakes 2,500 tons of freight are moved with a fuel consumption of ½ ton per hour. Additional data regarding fuel consumption on the western river towboats are desirable.

The handling of these stern-wheel boats for down-stream towing is remarkable. They are 158 feet to 160 feet long overall, 24 feet to 26 feet wide and 5½ feet deep, drawing 5 feet of water at the head when coaled with 40 tons and not quite 4 feet at the stern. The length between stem and transom is 135 feet, the diameter of wheel, 20 feet, the width of bucket 30 inches, and length of bucket 16 feet to 18 feet.

Barges

The barges originally used were 100 feet long, 24 feet wide and 8½ feet deep. Five of these barges, with a towboat, make up a towing unit. Since the widening of the locks, the barges and boats have been made 26 feet wide, while in recent years steel barges, 200 feet long, are being built, thus replacing two of the wooden barges. The advantages of the longer steel barge over the two smaller wooden barges are smaller first investment per ton of carrying capacity, quicker loading and discharging of the cargo, less resistance per ton through the water, greater carrying capacity for the same dimensions of towboat unit, lighter draft when empty, and greater capacity on the same draft.

These steel barges are all of the same pattern, the hull being of quarter-inch open-hearth steel, built with a semicircular bow and stern of 10-foot radius with square sides 8 feet 7 inches depth, with a 16-inch sheer on either end, drawing 12 inches of water when light. They are almost all a full box shape, with an 8-inch round knuckle plate of ⅜-inch steel, with bow and stern rake plates of 5/16-inch steel.

The coal is carried in steel hoppers sheathed with wood, the carrying capacity of each barge on a 7½-foot draft being 1,100 tons. The wooden barges, while drawing only 12 inches when new, gradually become waterlogged and draw as much as 18 inches light after they are about four years old. The life of the steel barge is about four times that of a wooden barge. Two of these steel barges ahead of the towboat, and one wooden barge of 500 tons capacity alongside the towboat, make up a tow of 360 feet by 52 feet overall dimensions with a combined carrying capacity of from 2,500 to 2,700 tons of coal. An average speed of 6 to 7 miles per hour can be maintained either up or down stream, as the coal movement is a down-stream movement, while the up-stream movement consists only of towing empty barges. The round trip is completed in twenty-four hours.

Handling of the Stern-Wheel Towboats

The reliable handling of these stern-wheel towboats in the down-stream movement is due to the position of large rudders forward of the stern wheel. This feature, which is otherwise a handicap, proves of advantage in quick flanking and maneuvering of the heavy tow. The action of the water from the wheel on the rudders when stopping or flanking is immediate, and anyone who has watched these towboats deliver their barges at landings and take out empty or loaded barges, is tempted to believe the pilot's boast that he can thread a needle with his boat. The heavy weight of the boat, otherwise a disadvantage, proves a great aid in this particular down-stream movement, and for handling work. The large paddle wheel is in any case an efficient propeller, and its high efficiency is maintained even at low speed, while the small screw propeller of restricted diameter, such as is necessary in shallow draft boats working in a tunnel under the stern, loses its efficiency rapidly with the falling off from the normal speed of the propeller.

On the other hand, the serious handicap of the stern-wheel boat is the unfavorable distribution of weights; the bad steering qualities when going ahead and the laboring in shallow water due to the squatting of the boat at the stern and the consequent deeper immersion of the wheel. According to curves published by Professor Herbert C. Sadler, of the University of Michigan, showing the relation between squatting and increasing load, squatting and speed, squatting and channel depth, it is shown that up to a speed of 8 or 9 miles through the water in boats of 150 feet length and over the squatting is serious only if 6 feet of water and less are under the bottom of the boat. There are stern-wheel boats that are known as squatters and others as shallow water runners, for which 8 feet of water is sufficient to run in with a fair speed. This is due to the design of the stern, the position of the wheel relative to the hull and the trim of the boat. A towboat has in addition to that the advantage that her nose is hooked solid into the barges which she tows, keeping her from squatting.

The heavy stern-wheel boat engines, even of the more modern compound type, seldom require repairs. Some of them have run for twelve years in day and night service every day in the year with only a few dollars' worth of repairs. These engines are of 500 horsepower of the tandem compound type, with 12-inch high-pressure and 24-inch low-pressure cylinders and a stroke of 72 inches, turning at from 16 to 18 revolutions per minute, supplied with steam at 200 pounds pressure with cut-off at ⅝ of the stroke. As these boats are operated day and night through locks, leaving loaded barges at one place and taking up other barges at various landings twice in twenty-four hours with only one engineer on watch in the engine room, it is evident that the engines have come up fully to requirements of endurance and reliability. The general construction of the engines is simple; all parts are of ample dimensions, and all movements are extremely slow, thus the parts are subjected to very little wear. If it were not for the fact that these engines are entirely too heavy, too clumsy in their design and too wasteful of steam in their operation, they could be called an unqualified success.

Long Distance Towing

The comparison between the cost of transportation by

water and by railway, as shown in the above case, is typical for the new towing industry on western rivers. It shows what has been done on an improved river and indicates what can be done elsewhere. It is true that there are not many of these enterprising organized towing companies on the western rivers, but there is room for an unlimited number of such concerns. Navigation on the Monongahela River is by no means a slack water navigation, in spite of the great number of locks, and cannot be compared with the Warrior and Tombigbee system in the Alabama coal districts, which is a typical slack water navigation for barges drawing 6 feet.

Furthermore, this Monongahela towing industry, being short distance navigation, is not typical of the towing industry on the Ohio and Mississippi rivers. It is slightly in advance of the widely known towing movements of the large coal fleets on the Ohio and Mississippi rivers, which is distinctly a long distance navigation. The ton-mile cost diminishes in direct proportion to the increase in tonnage and distance, and it will be found that in the large coal fleets on the Ohio and Mississippi the cost of transportation is reduced to a quarter of a mill per ton-mile, even with an unnecessary high daily towboat expense, while the Monongahela coal is moved at a cost of .6 mill per ton-mile. The large coal fleets, however, move in units of 40 barges of 1,000 tons each, or in units of 40,000 tons from Louisville, Ky., to New Orleans, La., the empty barges returning in forty days. The daily towboat expense is $300 (£62), or the coal is transported a distance of 1,500 miles for $12,000 (£2,480) at a rate of .2 mill per ton-mile. To this figure, however, must be added the heavy depreciation of the cheaply-built wooden barges and the great losses through storm and navigation hazards, which bring the total cost to an unproportionately higher figure.

The cost of loading is almost negligible, as the loading of this coal is accomplished by gravity. The unloading is done at the expense of the buyer. If he has to do it by hand labor, it will cost an average of 25 cents (1/0½) per ton, or as much as the total cost of transportation. It is customary, however, in western river towboat practice, to buy a whole barge load of coal and take the barge as a fuel flat alongside the boat and unload the coal during the voyage as needed. Thus the unloading is done by deckhands which have to be carried on the voyage, anyway. Of course this argument is in many cases misleading, as the deckhands refuse to do the coal passing and a great number of special coal passers have to be carried on the boat for the simple purpose of unloading this coal. Thus the unloading expense appears in the end as a heavy part of the running expense of the towboat. As a matter of fact, it is seldom realized what enormous quantities of coal are consumed daily on these large towboats. A thousand horsepower towboat with special high-pressure engines consumes 7 tons of coal per day, or as much as a 4,000 horsepower ocean or lake vessel would consume. Furthermore, twelve coal passers have to be carried to handle the coal. The introduction of compound condensing machinery reduced this consumption by about 40 percent, but obviously there is still room for improvement.

Movement of Merchandise

The movement of merchandise is necessarily a great deal more expensive than the movement of bulk freight, as a smaller quantity is moved at a time and an additional item has to be charged against the cost of transporting each ton of freight, namely: the soliciting of the freight and the heavier overhead expense. Also the handling of the freight is more expensive, although it is of interest to note that the handling expense, while higher per ton, is a much smaller fraction of the total expense than in the movement of bulk freight. The St. Louis Navigation Company, which was operating some barges and a towboat from St. Louis to New Orleans in 1911, showed the following division of expenses:

1. Actual cost of transportation per ton, $2.75 (11/5½); actual cost of transportation per ton-mile, 2.2 mills.
2. Loading and unloading per ton, 95 cents (3/11½); loading and unloading per ton-mile, .75 mill.
3. Overhead expense, soliciting per ton, $1.25 (5/2½); overhead expense per ton-mile, 1 mill.

Total expense per ton, $4.95 (1/07/½); total expense per ton-mile, 3.95 mills.

The average railroad rate for the commodities carried was 25 percent higher than the water rate, but the actual cost of water transportation, almost 4 mills per ton-mile, was too high to be on a strong competitive basis with the railroad. The first item could be reduced by carrying a greater tonnage and by reducing the towboat expense. With lower daily operating expenses, some towing companies move such freight as lumber, coal and stone in 2,000 and 2,500-ton units up-stream in the existing 8-foot channels in the Mississippi for a cost of 1 mill per ton-mile, and in stretches allowing a 6-foot draft for 1¾ to 2 mills per ton-mile. So there seems to be no reason why the cost of transportation of merchandise with the same towboat system cannot be reduced to the same proportional figure.

The second item, the terminal expense, can be reduced by building or improving river terminals, although this item cannot be reduced to the same extent as the cost of transportation. It must be borne in mind that the river terminal is more important as a feature of soliciting freight and distributing the freight than of the mechanical conveying and loading of the freight. In fact, the handling of this merchandise freight is merely a mechanical detail of more or less local character, while the efficient connection of the river terminal with the stores, railroads and transfer service is of an importance that cannot be overestimated.

The third item, the overhead expense per ton and ton-mile, will reduce itself automatically with the expansion of the merchandise movement.

Conclusion

It can be seen from the foregoing that the towing industry on the western rivers can be carried on with marked success wherever sufficient capital is invested and the modern means of management are adopted that are prevalent in other branches of freight transportation. The few remaining navigation companies on the western rivers, that still adhere to the independent packet boat service without railroad connections, lose in importance and prestige year after year, and will have to restrict their activities more and more to the local excursion trade, while the towing industry will gradually become an important feature in the problem of freight transportation.

Notice to Mariners.—A plant of the Merritt & Chapman Derrick & Wrecking Company is now engaged in laying a 36-inch submarine pipe line known as the Narrows Siphon across New York Bay from the foot of Seventy-ninth street, Brooklyn, N. Y., to Tompkinsville, Staten Island, N. Y. Passing vessels are requested to slow down and to give this plant as wide a berth as possible.

Fig. 1.—View of the *Slack Barrett* Ready for Service

Steel Stern-Wheel Towboat Slack Barrett

Light Draft Towboat for Use on the Ohio and Mississippi Rivers —Hog-Chain and Wheel-Chain Braces Replaced by Deep Trusses

The launching of the steamer *Slack Barrett* at the shipyard of the American Bridge Company, Ambridge, Pa., on March 31 of this year, marked a step in advance in construction of boats of this type, as the *Slack Barrett* was the first stern-wheel towboat of the Western River type to be built without hog-chain and wheel-chain braces. The hull and upper works, up to and including the boiler deck, were built entirely of steel, the only wood used in the entire construction being the cabin and pilot house above the boiler deck, and even here the paneling in the kitchen and laundry was of steel plating on a wooden frame.

The hull is 140 feet long, 32 feet wide on deck, and has a molded depth of 5 feet 3 inches at a point about 10 feet forward of the forward end of the cylinder timber. The sheer forward is 27 inches and aft 12 inches. The crown of the deck is 4 inches, the sides having a flare of 12 inches, turning into the flat bottom on a 12-inch radius. The bow of the boat is of the scow type, the deck line being brought in slightly, beginning at a distance of 8 feet from the end. The stern is also scow-shaped, the deck lines running parallel clear to the stern transom. Three "bustles" are built in the stern rake, thus keeping a constant clearance for the three counterbalanced rudders throughout their entire swing. The forward marginal lines of the "bustles" are bounded by a 1½-inch, half round, to prevent driftwood fouling the rudders. The length of both bow and stern rake is 20 feet.

Six transverse watertight bulkheads divide the hull into seven watertight compartments. Four longitudinal trusses are worked intercostally between the transverse bulkheads, being connected to the bottom and deck plating at

Fig. 2.—The Hull Under Construction, Showing Framing, Transverse Bulkheads and Longitudinal Trusses

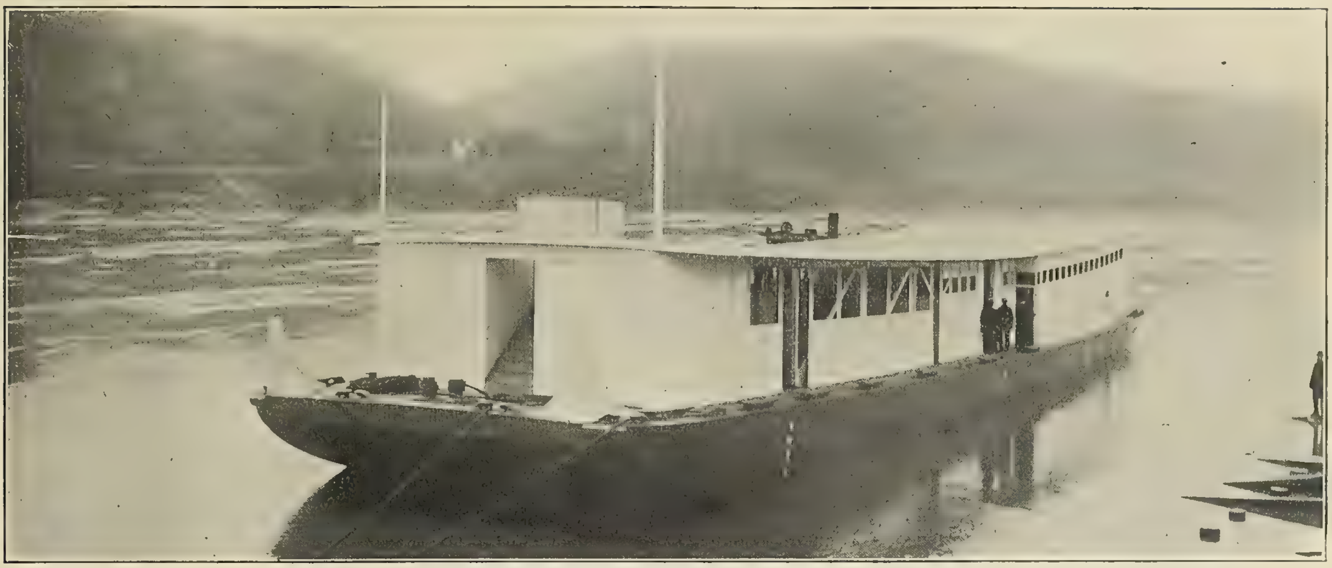


Fig. 3.—Hull of the *Slack Barrett* Just After Launching at the Ambridge Yards

their intersection, as shown in Fig. 2. The two inboard trusses are of the lattice type between bulkheads Nos. 1 to 6, while the two outboard trusses are of the lattice type between bulkheads Nos. 1 to 4, the remaining portions of all four trusses being non-watertight plate bulkheads, notched for the passage of deck beams and floors, which are continuous from side to side of the boat. The deep trusses which replace the hog-chains and wheel-chain braces are placed in the same vertical plane with the outboard trusses in the hull and with the wheel beam. Diagonal and vertical members of the deep trusses over the wheel beam are so located as not to interfere with the installation or operation of the engines.

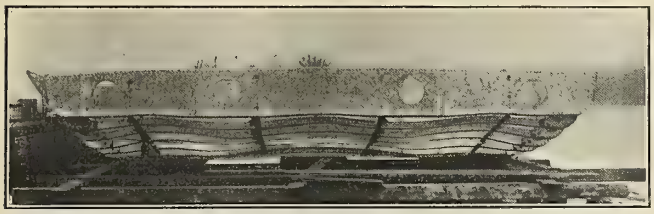


Fig. 4.—Stern Framing

The side walls, interior partitions and splash bulkheads between the main and boiler decks are all of 5-pound plating, suitably stiffened with angles.

The boat has two horizontal 40-inch boilers 28 feet long, with two 14-inch flues each. There is also an upright auxiliary boiler 44 inches in diameter and 8 feet long. The main boilers are allowed a working pressure of 224 pounds per square inch and make steam easily for the two tandem compound non-condensing engines. All of the live and exhaust steam pipes on the boat were furnished by the Charles Barnes Company, Cincinnati, Ohio.

The engines are 12 inches by 21 inches by 7 feet stroke and are equal to a simple engine 17 inches by 7 feet, or about 375 horsepower each. The engines drive a wheel 19 feet diameter and 22 feet long with fourteen 32-inch buckets at a speed of 23 revolutions per minute. With coal on board the boat draws 3½ feet of water.

The auxiliaries include a 10 kilowatt electric generator and a small turbine plant. A one-ton refrigerating plant cools a box 6 feet by 7 feet by 9 feet, inside measurement,

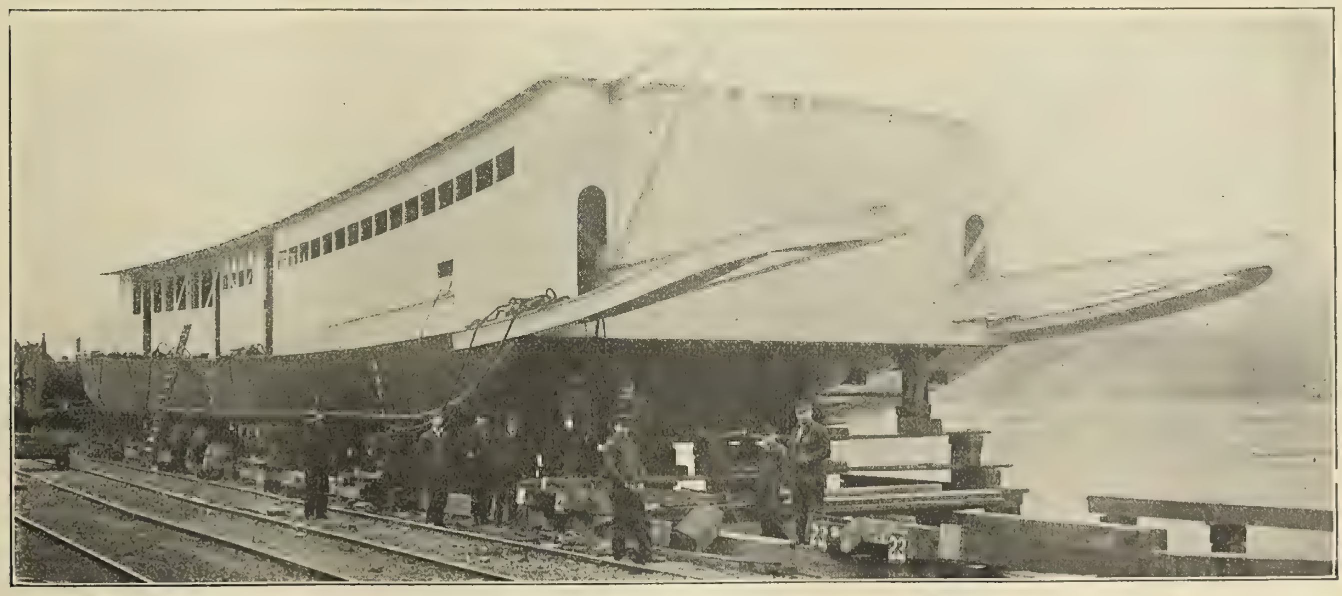


Fig. 5.—Stern of the *Slack Barrett*, Showing Deep Wheel Trusses

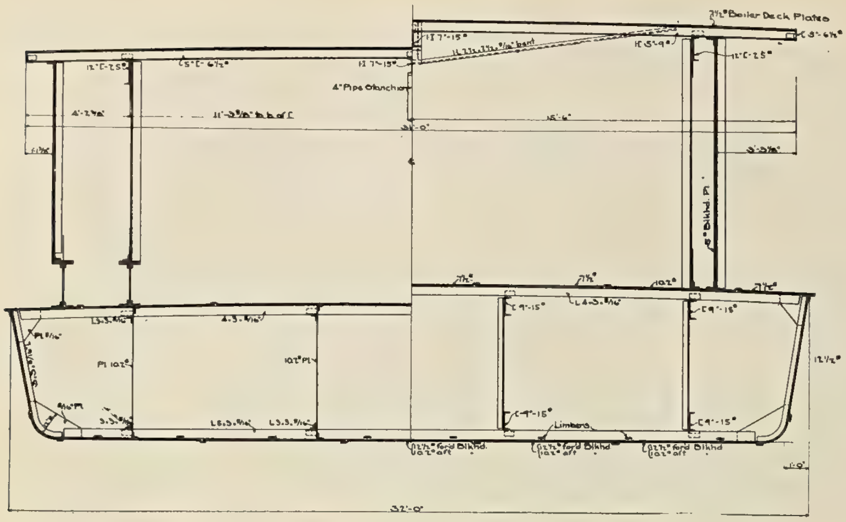


Fig. 6.—Midship Section

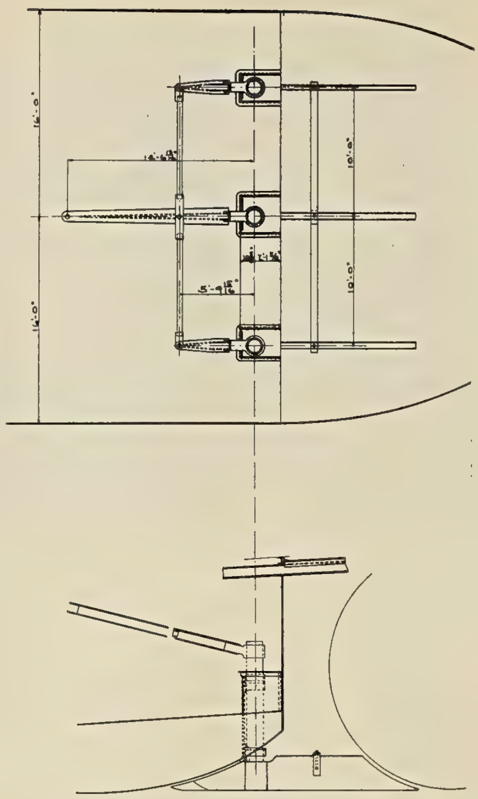


Fig. 8.—Arrangement of Rudders

for 24 hours on 10 hours' running, besides making a small quantity of ice. By an arrangement of running coils through the brine tanks ice water is piped to sanitary drinking fountains throughout the boat.

Ten staterooms provide ample accommodations for officers and crew and two large and elaborately fitted staterooms are provided for the accommodation of guests.

The three large balanced rudders are operated by an improved steam steering gear supplied by the Charles Barnes Company, Cincinnati, Ohio. The steering device consists of a steam cylinder placed immediately over the rudders in close proximity to the stern of the boat. The steam cylinder is 8 feet long and is provided with a connecting rod that takes hold of the tiller directly. In turn the cylinder is provided with a very sensitive supply and exhaust valve of the rotary pattern perfectly balanced, so that its movement under pressure requires slight resistance in handling from the pilot house. Two vertical shafts extend up through the deck of the pilot house, one on each side of the large pilot wheel. These shafts are in turn united by a sprocket chain under the deck of the pilot house. Both shafts move simultaneously, so that the pilot may handle the steering engine from either side of the pilot wheel. A third vertical shaft, connecting directly with a second sprocket chain, leads from the hurricane deck to the lower side of the boiler deck. The lower end of this shaft is provided with a double crank, which in turn is attached to fore and aft rods about ⅜-inch diameter leading back to the stern of the boat, where they connect to the steam valve. When the pilot desires to steer by hand

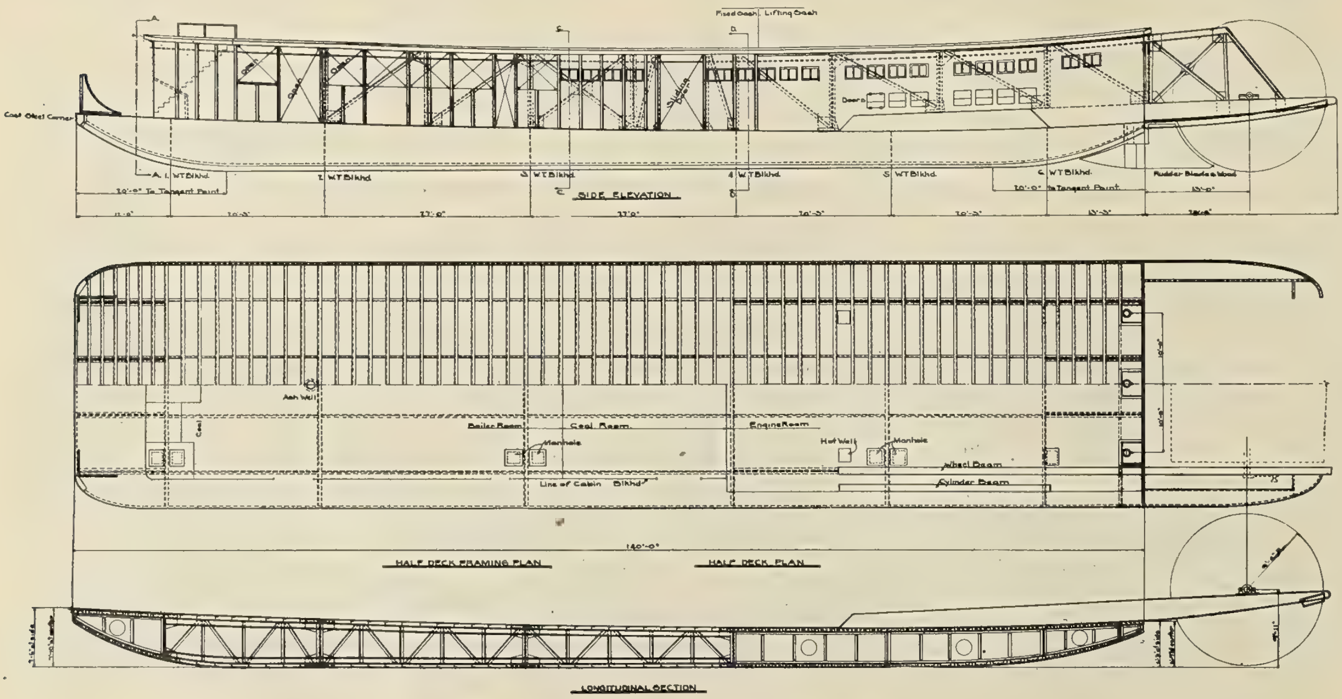
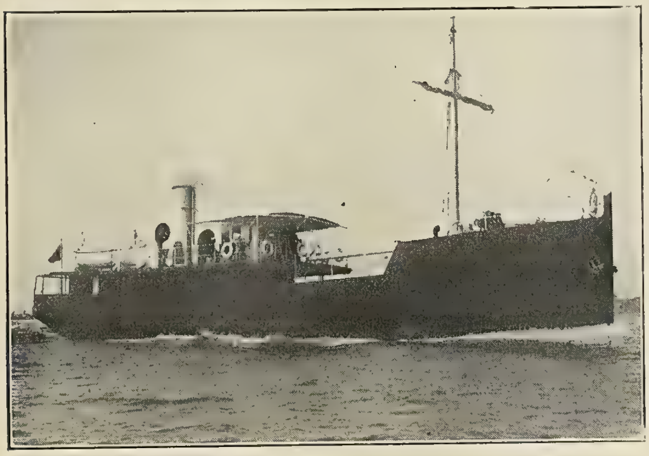


Fig. 7.—Construction Plans of Towboat Hull

he simply moves the handle to a given point which is indicated by an index plate. An ingenious brake, operated either by steam or foot power, is attached to the steering device. If the pilot desires to cut off the steam he simply moves the handle to a given point, which is also indicated on the index plate. He then has perfect control of the brake by a treadle coming up through the pilot house floor and can use his brake by foot power without taking his hand from the pilot wheel.

Shallow Draft Steamers for Intercolonial Service

Three vessels, named the *Taff*, *Towy* and *Teign*, have recently been built by Messrs. Day, Summers & Company, Ltd., Southampton, for the Royal Mail Steam Packet Company's inter-colonial service, at the West Indies. The three vessels are each 110 feet long, 21 feet beam and 11 feet deep. They are fitted with single screw compound engines, having cylinders of 15 inches and 30 inches diameter and 24 inches stroke. A large hold forward is capable of carrying about 100 tons of cargo, giving the boat



Royal Mail Steamship *Taff*

a draft of 7 feet 6 inches. The boats are intended for day use and have only deck accommodations for passengers. A steam windlass, winch and steering gear are also fitted. It is claimed that a mean speed of 10 knots was obtained on the measured mile.

Crane Barge

A crane barge of novel design has been built and equipped by Messrs. Ritchie, Graham and Milne, engineers and shipbuilders, of Whiteinch, Glasgow, to the order of the Brazilian Government. The barge is 150 feet long, 50 feet wide and 8 feet deep, and is fitted with twin-screw engines, having cylinders 13 and 26 inches in diameter by 18 inches stroke. Steam is generated by two Babcock & Wilcox boilers. There is a complete salvage pumping plant, air compressor and diving apparatus, together with a steam windlass and steam winch. The 30-ton and 5-ton steam cranes installed were supplied by Sir William Arrol & Company, Ltd., Glasgow. The vessel has accommodations for officers and crew.

NEW YORK MOTOR BOAT SHOW.—The eleventh annual New York National Motor Boat Show will be held in Madison Square Garden, New York City, January 30 to February 6, 1915.

Single and Twin Screw Tugs for River Work

A type of single screw tug, suitable for both sea and river work, built by Edward Hayes, Watling Works, Stony Stratford, is illustrated in Fig. 1. The vessel is 51 feet long overall, 11 feet wide and 6 feet 2 inches deep at the side amidships, with a draft of 4 feet.

The engine is of a design specially suited to this type of boat and is a standard Hayes compound steam con-

Fig. 1.—Single-Screw Tug

densing set, with cylinders 8 inches and 16 inches in diameter by 10 inches stroke. Steam is supplied by a return tubular boiler, of the marine type, built under Lloyd's Survey to work at a steam pressure of 120 pounds. The engines drive a three-bladed propeller designed to give maximum efficiency in towing at 260 revolutions per minute.

An auxiliary donkey pump is fitted for filling the boiler when the main engine is not running, and the bilge can be drawn off by an auxiliary hand deck pump from all five compartments of the vessel. The towing gear consists of a strong hand-slip hook mounted on a well-stayed oak post.

The vessel is arranged with roomy cabins under the deck forward and aft. The boiler room is covered with a steel casing, and both engine and boiler rooms are ventilated by two large cowls. It is claimed that the vessel is a good sea boat and that under ordinary conditions a speed of about 12 miles is attained.

A second type of boat built by the same firm is a twin

Fig. 2.—Twin-Screw Launch Tug

screw steel launch tug, as shown in Fig. 2. This vessel is 60 feet long, 11 feet wide and has a draft of 3 feet. Each propeller is driven by a separate compound engine exhausting into a separate condensing plant. This small plant is placed central in the boat just aft of the main

engines, and is so arranged that the deck covers it, thereby allowing extra deck space for cargo. The pumps are driven by a small compound steam condensing engine having cylinders 3½ and 7½ inches diameter and 5 inches stroke. Steam is supplied by a return tubular boiler of the marine type.

There are several methods used in arranging the accommodations of this vessel, according to the requirements. That shown in the illustration consists of flush decks, for the accommodation of the crew, with cargo spaces beneath and the towing gear fitted aft of the engine room, although other arrangements can be made, if desired.

Stern-Wheel Boats vs. Screw-Propeller Barges for Shallow River Navigation

BY H. S. KEALHOFER

The economical and profitable handling of traffic on the shallow, inland waterways of the South has been a perplexing question to river-transportation people and marine engineers for some time, and especially since so many of the inland navigable waterways have been paralleled by rail lines which are willing to handle traffic between water competitive points on a basis that would be unprofitable to the river transportation lines.

There are numerous questions that enter into the cost of successfully conducting river transportation which must be solved in such a manner as to render to the patrons of such transportation the maximum amount of service, at a cost lower than rail transportation with its modern facilities, in order that the business can be profitable to the operators of such water lines and satisfactory to their patrons, but this article will treat only of the comparison of equipment used for such purposes.

The Old-Time Steamboat or "Packet" Business

Before the present development of rail transportation, and the building of rail lines which came in contact with every principal water or river point, the old-time steamboat or "packet" business was conducted on a large and profitable scale and at a cost to the shipper which was most satisfactory. The development of this water business on the rivers of the South caused such competition between the water carriers that the highest class stern-wheel and side-wheel boats were developed for this service, and marine engineers vied with each other in the construction of boats that could navigate the shallowest streams and at the same time carry an enormous amount of freight on low draft at the greatest speed that could be obtained. The result of all this competition was the perfection of the light-draft, powerful and swift steamer, equipped to move rapidly in a good depth of water, to negotiate very shallow streams and short bends, and to overcome the various obstructions that always made successful inland navigation so difficult and hazardous. The applied principle of these light-draft boats is hard to understand except by those who have had actual experience or observation of their operation on the rivers of the South, and a simple explanation of the advantages of the stern-wheel boat might be of interest to those who have never been able to see a clear demonstration of their work, and who only have an opportunity to see such boats tied up at a city wharf, or plodding along in a deep, long stretch or "reach" of water.

Advantages of the Stern-Wheel Steamboat

The writer has made numerous trips over the principal rivers of the South—between such points as New Orleans and Cincinnati, Memphis and Little Rock, Wetumpka, Ala., and Mobile, Ala.; Savannah and Augusta, Ga.,—and has made investigations of numerous other streams looking into the feasibility of their successful navigation. He, therefore, speaks from actual experience and observation. The principal obstacle to such navigation is low water, which, as expressed by the deck hand, "makes the bottom of the river too near the top." The negotiation of these shallow places has been the most frequent and expensive trouble. It was the main thing to be overcome by the marine engineers, and has resulted in a remarkable development of steamboats for shallow streams. Another obstacle is the rapid rise and fall of the inland rivers, especially those which depend upon rain for their volume of water and are not supplied by reservoirs or an extra flow of water at their source from large lakes or springs. It is a notable fact that a boat has been loaded down to the guards with freight with every indication of a good river, and before it could reach some of the more shallow places the water had run out with such rapidity that it had fallen from one to eight feet. Such a boat was confronted with the necessity of getting over, or by, the long reefs or sand bars which were thus brought into evidence. In some instances they could hug the bank on the deep side and work around the point of the bar, which generally extended out to a short bend in the river—the bend being generally one of the causes of the formation of the bar. Now, to work around one of these points, or "bites," it is necessary for the boat to go backwards and forwards in a see-saw manner to keep in the deepest part of the water and within the very narrow, circular channel that had been caused by the extension of the bar and the lowering of the water. In working around these corners the boat frequently rubs the bottom and sometimes gets fast on it.

Now comes the exemplification of the advantages of the flat-bottom, stern-wheel boat over any other kind of river craft that might be placed in a similar situation. Few people seem to realize that when a boat is resting on a sand bottom in 24 inches of water the stern-wheel can be worked backward with sufficient rapidity to force water under the bottom of the boat and actually raise it 6 to 10 inches from the bottom. At the same time, this maneuver so cuts the sand or mud that the actual force of the stream will wash out a channel. By repeated force of this kind such a craft is able to get over shallow places which would otherwise prove an impassable barrier. Another principle of the shallow-draft, stern-wheel boat is that the force of the wheel beating down against the water raises the stern of the boat and pushes ahead so rapidly that the force of the bow against the water actually raises the head out of the stream so that the boat, while drawing 24 inches of water loaded, can actually travel on water 16 to 20 inches deep when under full headway. Of course, the power of these boats could not be obtained without high-class machinery and boilers with good steam capacity, and it was one of the problems of marine engineers to so construct and distribute the weight of such machinery and boilers as to keep the boat on an even keel and at the same time have very little effect upon the trim of the boat when fully loaded with freight. Another feature of the stern-wheel boat is the fact that the machinery and everything connected therewith is above water, and in case any of the buckets of the wheels are broken, or any other damage is done to them, they can be readily repaired without much difficulty.

It is true that our Government has been spending large sums of money for deepening inland waterways, building jetties, removing obstructions and otherwise clearing

shallow streams for navigation, but the public little realizes the vast amount of work that has yet to be accomplished to perfect a large number of rivers so that they will be available all the year for continuous navigation with a fixed minimum of depth at extreme low water.

Importance of the Barge and Towboat

Until these obstacles can be fully overcome by the Government it can be briefly stated that the best and most economical way to utilize such rivers is by the use of large covered barges to be handled by small, powerful, light-draft towboats. The towboats will not carry any freight, and, as the barges will not be burdened with machinery or heavy superstructure, they could carry three times as much freight on 24 inches of water as the ordinary stern-wheel steamboat could carry on 30 inches; therefore, one towboat with a fleet of six barges could do more work than an equal number of steamboats and at a minimum cost, approximating the operation of one steamboat. It would be expected that the towboat would be continuously moving with at least two loaded barges between terminals, and while it is enroute with two barges, two at either end of the line will be loaded or unloaded and ready for handling immediately on the arrival of the towboat, which will release its tow of two barges and pick up the two loaded barges for return movement. Instead of the expense of a crew for about six boats and their enforced idleness while being unloaded and loaded, there would be an expense of only one crew on one boat, which would be constantly moving, and the barges could be loaded and unloaded with labor that would be paid only for the work actually performed; this would also obviate the necessity of carrying on each trip a large deck crew, which has to be paid good wages and fed while en route. This method would apply principally to large traffic between regular points.

Within the past few years some enterprising marine engineers have suggested, and they have endeavored to demonstrate, self-propelled steel barges as a solution of the present expensive method of handling freight on shallow-draft, stern-wheel steamers. These barges have been operated successfully in Europe in slack water, deep streams and canals, which do not present the hazards of the inland waterways of the South. In Europe they do not have to counteract the swift-changing currents, sand bars, extremely short turns and other obstacles which are in every stream of the South.

Self-Propelled Barges

The Alabama & New Orleans Transportation Company has constructed some very large steel barges to be propelled by twin screws with a maximum of 150 horsepower, whereas the horsepower of the stern-wheel boat is from 300 to 450. The well-known principle for the successful operation of screw-propeller boats is that deep water is necessary to secure power, and the deeper the stern is set by the working of these propellers, the higher is the head of the boat out of water. Anyone can observe this by watching a motor boat moving on the water at a fair rate of speed. The barges in question were constructed for movement through the Lake Borgne Canal, Mississippi Sound, Mobile Bay and up the Mobile, Tombigbee and Warrior Rivers. The United States Government has recently completed about thirteen locks and dams on the Tombigbee and Warrior Rivers with a minimum depth of about 6 feet. These locks and dams afford practically slack-water navigation, and, as the fixed minimum depth is sufficient, there should be very little trouble in operating such barges between the head waters of the Warrior and the Mississippi Rivers via the route indicated. This is the only waterway in the South upon which such barges might be profitably demonstrated, and the writer understands that with all of these favorable conditions the operation of such barges has not been entirely successful.

The question for consideration, therefore, resolves itself into: "How could these self-propelled barges be operated on rivers which have not been locked and dammed and still offer the impediments of swift currents, sand bars, short turns, rocky banks, projecting timber and other numerous obstructions?" If these self-propelled barges can overcome the difficulties that are now confronting the light-draft, powerful, stern-wheel boats, an economical and profitable operation will be assured for shallow-water navigation. But it must first be demonstrated that they can negotiate the "bites," or short turns around sand reefs, and that they are capable of getting off the bottom, as can the stern-wheel boats, with their powerful wheels and balanced rudders. The nature of self-propelled barges requires deep water, and should they land on a bar they are high and dry with their engines stopped, and they are without the same means to extricate themselves from such an awkward position as the stern-wheel boats possess.

It is the writer's opinion that the self-propelled barge is not yet the solution for successful operation on shallow rivers, chiefly because of the conditions surrounding navigation as outlined above.

Alterations to Power Plant of Stern-Wheel Towboat Advance

BY M. VON PAGENHARDT*

The stern-wheel towboat *Advance*, of the Kansas City Missouri River Navigation Company, Kansas City, Mo., entered into regular towing service on August 2, after extensive alterations had been made to its power plant. The noteworthy feature consisted of replacing a 130-horsepower steam plant by a 600-horsepower steam plant without materially increasing the draft of the boat. At the time these alterations were under contemplation it was found that all existing stern-wheel towboats of similar power displaced betwen 400 and 500 tons, and that a careful estimate of weight and trim had to be made to accomplish with a hull of 125 feet length and 25 feet width with an allowed draft of 3 feet 6 inches what boats of 140 feet to 150 feet length and 28 feet to 32 feet width accomplish with a 4-foot draft.

Calculation of Weights and Displacement

DIMENSIONS OF VESSEL

Length from stem to transom	125 feet 00 inches
Beam, molded	25 feet 00 inches
Depth, molded	4 feet 10 inches
Sheer forward	9 inches
Sheer aft	8 inches
Draft with 100 steam-hours' fuel	3 feet 6 inches
Displacement at 3 feet 6 inches draft (block coefficient = .80)	280 tons

WEIGHTS OF VESSEL

Complete weight of hull and cabin	130 tons
Machinery and boilers	90 "
Fuel, 250 barrels, at 310 pounds	40 "
Equipment and reserve	20 "
Total	280 tons

* Naval Architect, Kansas City Missouri River Navigation Company, Kansas City, Mo.

Actual draft of boat with 250 barrels of oil...... 3 feet 5 inches forward
3 feet 4 inches aft

REGISTER TONNAGE

Gross tonnage, 90; net tonnage, 80.

The analysis of the weights showed that only 90 to 95 tons were available for the complete machinery and boilers, or 300 to 315 pounds per indicated horsepower, while the plants of other stern-wheel towboats of this power

Fig. 1.—Towboat *Advance*

weigh in the neighborhood of 125 to 170 tons, or 415 to 560 pounds per indicated horsepower. This weight of 125 to 170 tons is apparently divided as follows:

MACHINERY

Main engines	25 to 35 tons
Shaft and wheel	14 to 18 "
Condenser equipment	9 to 15 "
Auxiliary engines	9 to 15 "
Piping	8 to 12 "
Total	65 to 95 tons

MACHINERY

	Pounds	Pounds per I.H.P.
Main engines, complete, including pitmans, cam motion, shipping up engines, etc.	34,440	57.6
Shaft and wheel	20,800	38.0
Condensing equipment	7,800	13.0
Auxiliary machinery	10,200	17.0
Piping	8,105	13.8
Total	81,345 40.67 tons	139.4

BOILERS

Two boilers, specially designed for steamboat *Advance*, of the combination type, including superheaters, breeching, stack and stack casing	94,460 or 47.23 tons	157.3

The accomplished result of the machinery weight of 40 tons against 65 to 95 tons of customary weight, representing a saving of at least 40 percent in weight, is of double importance in a stern-wheel boat, where the machinery is located near the stern, necessitating additional provisions for structural rigidity and the arrangement of counterbalancing weight forward. Thus a saving of weight aft represents a saving of counterbalancing weight forward, a reduction of bending moments and excessive stresses and, due to the closer proximity of engines and boilers, a saving of weight in piping.

BOILERS

The boiler plant presented a more difficult problem to solve. Here were found lacking all comparative data for a successful, light weight, high-pressure, river boat boiler. The usual boiler in these Western River boats was found to be the externally fired return flue boiler, which in its peculiar and successful adaptation to the conditions applying to Western River boats has received the epithet, the "Western River Boiler." And it must be acknowl-

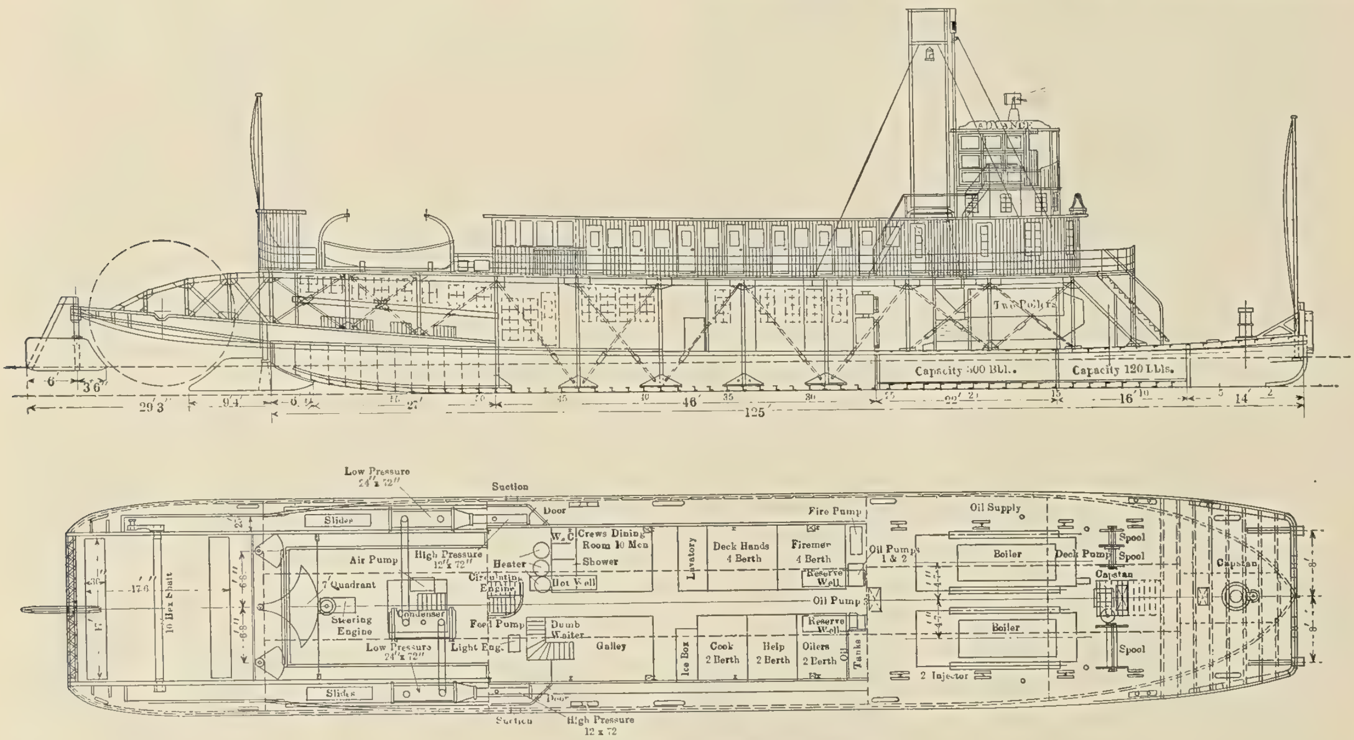


Fig. 2.—Profile and Plan of the *Advance*

BOILERS

Externally fired, flue, Scotch marine, Heine watertube, Bonson combination	60 to 75 tons
Total	125 to 170 tons

By a careful selection of the main and auxiliary engines and a preliminary lay-out of the plant, the weights of the *Advance* machinery were brought to 40.67 tons, or 130.4 pounds per indicated horsepower, as given below:

edged that the heat absorption, first in the shell, then after the proper expansion of the gases in the rear combustion chamber, in the flues, is simple and effective, the circulation of water is excellent, being both free and short, the liberating surfaces are ample on account of the wide-spaced flues. the division of steam and water takes place without interference, due to the large steam drums mounted on top of the shells connected with large pipes

to the shell, while the mud drums allow the precipitation of mud and the feed water inlet through them facilitates the circulation. This knowledge, being hard-gained knowledge, will always be retained and will govern our selection of boiler power. The four main factors, however, guiding us in the selection of boiler power, are:

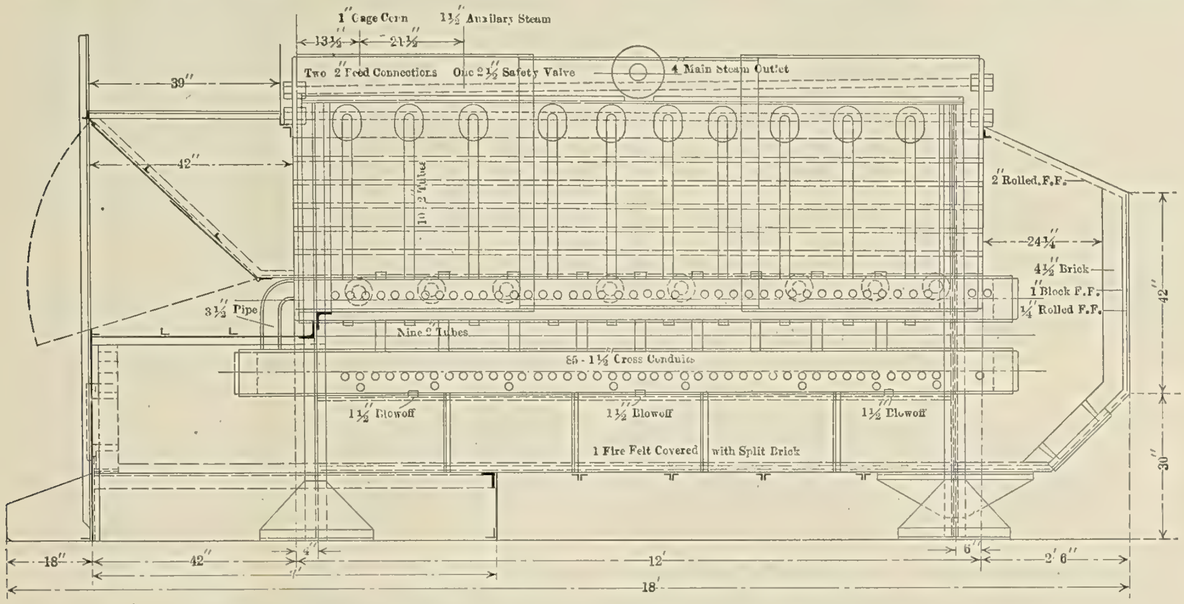


Fig. 3.—Oil-Burning Boiler, with Dutch Oven Furnace, for Towboat *Advance*

Safety, service, weight and economy. In a boat with "Western River Boilers," safety is neglected altogether, service is considered only in a limited way, weight not at all, and economy only in sporadic cases.

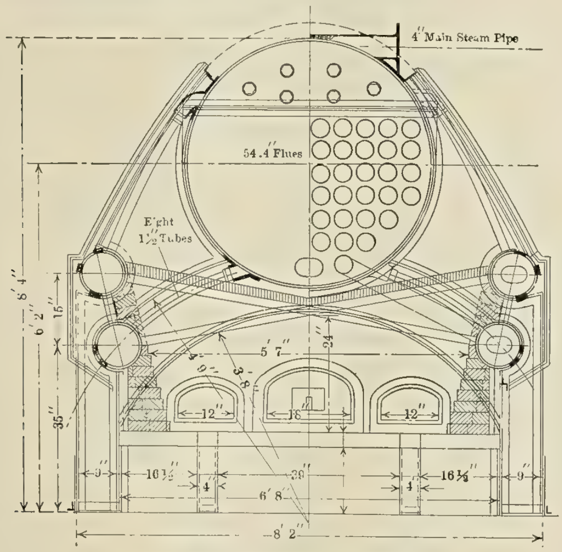


Fig. 4.—End View of Boiler

Of the other existing boilers, one may say that the Scotch marine boiler cannot carry the required pressure or is too heavy carrying the pressure. The firebox boiler does not stand a severe duration test, requires too much room and is too heavy and too expensive in repair. The watertube boiler does not stand the abuse nor the fluctuations of load nor the dirty water, and there are a number of combination fire and watertube boilers appearing and disappearing on the market, of which only a few are left at present—the Bonson boiler, the Hawkes boiler and one other that has appeared more recently, the Kidney boiler. It is a variation of this Kidney boiler that has been designed especially for the steamboat *Advance*, embodying the best features of the watertube and firetube types.

These two boilers, particulars of which are given below, have surpassed even the keenest expectations. They were designed especially for burning oil fuel and were guaranteed to evaporate 16 pounds of water per pound of oil, which they surpassed by almost half a pound, establishing a boiler efficiency of 83 percent.

Their complete weight is 42,655 pounds or 250 pounds per boiler horsepower (34½ pounds), or, figuring at 20

Fig. 5.—Interior of Furnace

pounds per indicated horsepower, 140 pounds per indicated horsepower, while in the report of the United States engineers on experimental towboats, March 24, 1914, the weight of flue boilers is given as 186 pounds per indicated horsepower, of Scotch boilers as 200 pounds per indicated horsepower, of B. & W. semi-marine watertube and Bonson combination boilers as 163 pounds per indicated horsepower, and of the Ward straight-tube watertube boiler as 91 pounds per indicated horsepower.

DETAILED WEIGTHS OF BOILERS

Weight of shell, drums and tubes	15,075 pounds
Weight of sheet-iron work	5,800 "
Weight of insulation	7,840 "
Weight of air furnace	2,750 "
Weight of valves and fittings	390 "
Weight of water	10,800 "
	42,655 pounds

Weight of superheater (128 feet)	1,450 pounds
Total	44,105 pounds

These two boilers require a space of 17 feet 6 inches in width, 18 feet length and 8 feet 6 inches height with the necessary length of room forward and aft of the boiler as required by law and convenience. The arrangement of tubes is such that every tube can be inspected and cleaned from the outside, and replaced if necessary; the construction has due regard for utmost flexibility of all parts taking care of expansion and contraction, the fire-tubes are welded into both front and rear heads; the exterior down-flow tubes are welded into the front heads and lower drums, while particular care is given to a light and durable insulation.

Special mention is made of the introduction of a Dutch oven particularly adapted for burning oil fuel, and the arrangement of a superheater in the smoke box or breeching, resulting in a superheat of 70 to 75 degrees.

HULL

The hull is of Siemens Martin steel one-fourth inch thick, built in 1907 by the Dubuque Boat & Boiler Works, Dubuque, Iowa, having wooden deck beams and a wooden deck. There were three watertight cross bulkheads, at 14 feet, 52 feet and 98 feet from the bow, separating the hull into four compartments. An additional watertight cross bulkhead 30 feet from the bow was added, creating two compartments for carrying fuel oil, and a longitudinal wooden center bulkhead was built for the length of these compartments to reduce the free moment of inertia of the oil surface by three-fourths. A steel deck of 3/16-inch thickness and steel deck beams were laid extending from the bow to the after end of the fuel oil compartments, 52 feet from the bow, while it was laid for the remainder of the deck surface only where locally required.

The providing of sufficient strength and rigidity for the additional stresses to be expected in this vessel with new machinery of four times the power of the old machinery required an increase of strength of the midship section. One could not be satisfied with the stretching of tie rods or "hog chains" over the endangered zone, as customary in Western stern-wheel towboats; these "hog chains" provide only for strength in one direction, against hogging, and can only be laid out for one load condition, the boiler weight forward, the engine and stern-wheel aft, etc., but where the trim of the vessel changes according to the weight and location of the bunker oil, and where, further, the dynamic stresses developed by the working of the wheel and the grounding of the boat exceed the static stresses of the weights, these "hog chains" are insufficient. Therefore, two solid steel trusses, similar to bridge trusses, were built into the hull, 9 feet from the center of the boat, 13 feet 6 inches high, extending over the whole length of the boat, forming in their after end a foundation for the main engines, and terminating in a graceful curve as stern-wheel supports. These trusses, weighing 14 tons, are not heavier than the customary construction of heavy cylinder timbers and "hog chain" braces; they remove one of the most serious objections to and faults of the stern-wheel type of power boat, the lack of longitudinal strength, and beautify an otherwise unsightly feature by substituting a low, graceful and for the greatest part invisible steel truss for a mass of diverging, towering braces and double sets of steel rods.

The construction proved its valuable claims at the launching of the completed vessel, where it so happened that the boat was supported at only two points and did not show any deflection. The construction has since established its rightful claims for absolute rigidity in numerous instances.

MAIN MACHINERY

The main machinery is of the Marietta Manufacturing Company, Marietta, Ohio, make, known as the McConnell steamboat engine of the tandem compound type, with the diameter of high-pressure cylinders 12 inches, diameter of low-pressure cylinders 24 inches, and common stroke 72 inches. The test showed an efficiency of 20 to 23 pounds of steam per indicated horsepower, with a piston speed of 270 to 300 feet per minute and a weight of 57 to 60 pounds per indicated horsepower. The 22-foot pitman is built of hard specification long leaf yellow pine and is the first of its kind designed in two halves, with a center steel partition for additional lateral strength.

The shaft is of hammered hexagon iron, 10 inches over the flat, with forged steel cranks, nickle steel wrist pins and forged steel collars, made by the Cleveland City Forge Company, while the four flanges are of an exceedingly light and strong design, made of cast steel having a tensile strength of 68,000 pounds per square inch, in all weighing 11,408 pounds or 19 pounds per indicated horsepower.

The stern wheel is of a radial type, which was preferred to the feathering bucket type after a careful comparison of their respective advantages under the particular working conditions of the boat. It is built entirely of wood, the arms, wheel circles, wedges and buckets being of selected oak and all braces and fillers of selected cypress. The diameter over the buckets is 17 feet 6 inches, over the arms 18 feet. The length of the buckets is 17 feet, the width 30 inches and the number of arms 12. The total weight, including stirrups, bolts and plates, is 9,380 pounds, or 15.6 pounds per indicated horsepower.

The condensing equipment consists of a circular steel shell surface condenser of 800 square feet cooling surface located opposite the low-pressure cylinders, allowing the shortest possible exhaust conduits; an air pump of the Blake Knowles make 6 inches by 12 inches by 8 inches, and a circulating pump of the Worthington make, C-5 volute, operated by a 5-inch by 5-inch A. B. Company engine, the aggregate weighing 7,800 pounds, or 13 pounds per indicated horsepower.

AUXILIARY MACHINERY

The auxiliary machinery has been reduced to the minimum, consisting of a main feed pump of the Blake Knowles horizontal duplex double-acting type 7¼ inches by 4 inches by 6 inches, an injector for auxiliary feed, a heater of the Griscom-Russell make, two additional heaters for make-up feed water, one hot well, one fire pump, one service pump, three oil pumps with heaters, an electric light engine of 7 kilowatt capacity of the General Electric Company make and a steering engine 4 inches by 4 inches of the Forbes make, the total weight being 10,200 pounds, or 17 pounds per indicated horsepower.

The main steam pipe is of 4-inch diameter, extra heavy pipe, with all valves and fittings of ferro steel for 250 pounds steam pressure, with seats of brass, with the exception of the throttle valve and seat, which is of nickle steel. The branch pipes are of 3½-inch diameter extra heavy pipe, while the auxiliary steam line is of 1½-inch diameter standard pipe. The total weight of the piping is 8,105 pounds, or 13.8 pounds per indicated horsepower.

There is a single stack of 48 inches diameter, with breeching and casing. The extreme height above the grates is 38 feet, a division plate extending clear to the top. Altogether the stack and breeching weighs 6,000 pounds, or 10 pounds per indicated horsepower.

The equipment, such as capstan and capstan engine, which is a 6-inch by 7-inch engine of the Marietta Manufacturing Company make, the water tanks, cable, anchor and lines, weighs 26,600 pounds, or 44.3 pounds per indicated horsepower.

Operation

On her trial trip the boat pushed a barge 200 feet by 36 feet, loaded to a draft of 3½ feet, at a speed of 5 miles per hour against a current of 4 miles per hour, the wheel turning 22 revolutions per minute. On a consecutive trip she pushed a barge 156 feet by 30 feet, loaded to a draft of 3½ feet, at a speed of 6¾ miles per hour against a current of 4 miles per hour, the wheel turning 24 revolutions per minute.

The World's Largest Ferry Steamer

Of unusual interest to the marine engineering world is the new train ferry *Contra Costa*, which is nearing completion at Oakland, Cal. This vessel will be the largest ferryboat ever built and represents the latest ideas in the design of ferry steamers, which incidentally have reached a remarkably high stage of development on San Francisco Bay.

The *Contra Costa* is being constructed by the Southern Pacific Railroad and will be used by them to carry passenger and freight trains across Carquinez Straits, between Port Costa and Benicia, Cal. She will supplement the ferryboat *Solano*, which for many years has held the reputation of being the world's largest ferry. The new vessel is built of Oregon pine throughout, 2,000,000 board feet of lumber being used in her construction. In order to insure against end or side collision fourteen watertight bulkheads have been provided. Any one of these bulkheads might be punctured without endangering the vessel. The design of the *Contra Costa* called for some exceedingly large timbers, and it is of interest to note that there are single timbers in the hull measuring 26 by 36 inches by 66 feet long, and others 116 feet in length by 18 inches square.

The principal dimensions of this vessel are as follows: Length overall, 433 feet; length over transoms, 420 feet; width over guards, 116 feet; beam, molded, 66 feet; depth (amidships), 19¾ feet; draft, light, 5 feet; draft, loaded, 6 feet to 7 feet.

The four tracks on the main deck will accommodate thirty-six freight cars and two locomotives or twenty-four passenger cars and two locomotives.

In order to provide a maximum amount of track space the propelling machinery has been placed below the level

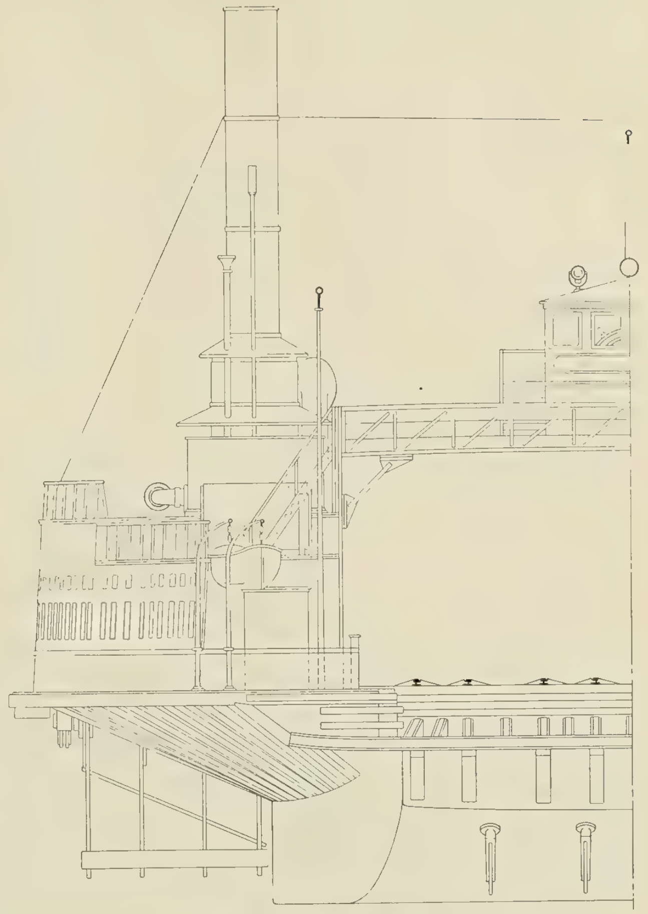


Fig. 2.—Half End View

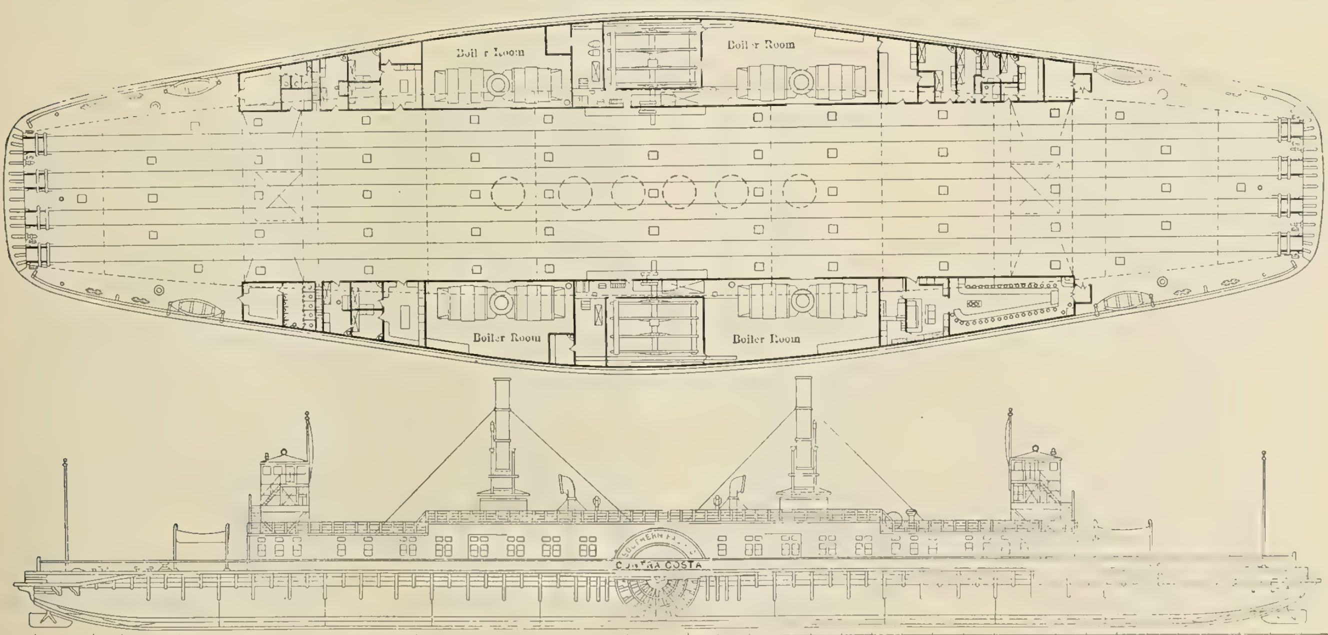


Fig. 1.—Car Ferry *Contra Costa*, Built by the Southern Pacific Railroad and Said to Be the Largest Car Ferry in the World

of the main deck. There are two separate engines of 2,500 horsepower, one located on either side of the vessel. This arrangement permits the independent operation of the two paddle wheels, so that in case of emergency the vessel may be maneuvered by reversing one wheel and sending the other ahead. The engines are of the low-pressure condensing type, equipped with Corliss valve gear, and set on an inclined engine frame. They were built at the railroad shops at Sacramento, Cal.

Steam will be supplied at a pressure of 60 pounds per square inch by eight Scotch dry back boilers, located on the main deck. Fuel oil is to be used under the boilers, the burners being supplied from two tanks of 7,800 gallons capacity, located below decks. Four water tanks of approximately 8,000 gallons capacity will supply water to the boilers and will also be utilized for filling locomotive tanks while crossing.

For the accommodation of local passengers a waiting-room, restaurant and bar have been provided in the superstructure. A small generating set will supply electric current for lighting purposes, and also for searchlights on either end of the boat.

Stern-Wheel Towboat *Aliquippa*, Built by James Rees & Sons Company, Pittsburg, Pa., for the Jones & Laughlin Steel Company

Fireproof Towboat Aliquippa

James Rees & Sons Company, Pittsburg, Pa., has recently completed for the Jones & Laughlin Steel Company, Pittsburg, a fireproof stern-wheel towboat, 153 feet long on the deck and 29 feet beam, with a 5-foot depth of hold, driven by tandem compound engines, 14 inches and 28 inches diameter by 7 feet stroke, fitted with lever balance poppet valves, with the Rees inside cam motion taken from the connecting rod and the Rees adjustable cut-off motion taken from the crosshead. The engines drive a paddle wheel 21 feet diameter with buckets 20 feet long and 36 inches wide, the average number of revolutions in heavy tow being 18. A cylindrical surface condenser with Warren air pump and circulating pump is fitted. The boiler is fed by a "doctor" pump through a feed water heater equipped with a brass pipe worm, which delivers the water to the boiler at a temperature of 200 degrees Fahrenheit. The other auxiliaries include a steam power capstan driven by a double 6-inch by 9-inch engine and a General Electric turbo-generating set.

The hull is divided into twenty-one watertight compartments by three longitudinal bulkheads 3/16-inch thick, and five transverse bulkheads secured to the bottom and deck plating by flanged intercostals. The frames throughout are 2½-inch by 3-inch by ⅜-inch angles spaced 18 inches apart, while the deck beams are 3-inch by 2-inch by ⅜-inch angles spaced on every frame. The deck is of ¼-inch steel plate, while under the boiler and coal box the deck is covered with 2 inches of concrete. The side bulkheads and framing for the cabin on the main and boiler decks is built entirely of steel plate and angles. The pilot house is also of steel, the balance of the cabin being of wood construction with panels of "Nevasplit" furnished by the Keyes Products Company, of New York, which by treatment are rendered non-inflammable. The boiler deck forward is made of plates and angles, the side rail and stanchions of galvanized pipe, and the inside of the cabin overhead of steel plate in order to make the cabin as fireproof as possible without building it entirely of steel.

Besides being practically fireproof, the boat has proved a great success in steering, especially in a river with strong current and dangerous bends. In light condition the boat is practically on an even keel, a feature which is very desirable for river craft which have to cope with low water conditions.

Hydraulic Suction Dredge No. 103

The hull of a wooden 18-inch hydraulic suction dredge, 100 feet long, 40 feet beam and 8 feet depth, having two decks and an operating room on top, contracted for by the Jennings Pump & Dredge Company, Chicago, Ill., is now at the docks of the Marine Iron Works, Chicago, for the installation of her boilers and machinery, which were built by this company. There are four boilers, each 90 inches diameter by 144 inches long, with single furnaces 44 inches diameter, built according to the Hartford Inspection Rules, for a steam pressure of 175 pounds per square inch. The battery of four boilers, which is installed on the main deck, is supplied with feed water by two Worthington ram pattern pumps, each 7½ inches by 5 inches by 6 inches.

The machinery consists of a triple expansion engine with cylinders 13½ inches, 19 inches and 33 inches diameter by 16 inches stroke, connected with an 18-inch Jennings hydraulic suction pump supplied by the Jennings Pump & Dredge Company. Both the engine and pump

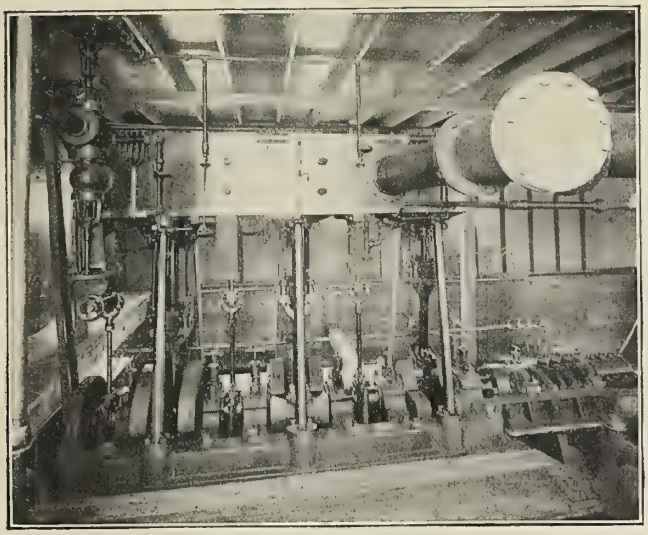


Fig. 1.—Pumping Engine

are securely fastened to a structural foundation, which in turn is bolted to a series of four longitudinal and four athwartship bulkheads, running the entire length and width of the hull, and of very substantial construction, so that when the tests of the machinery were made the hull showed an entire absence of vibration.

The engine room auxiliaries consist of a Worthington ram fire pump, 7½ inches by 5 inches by 6 inches, connected to the fire lines; a condenser pump of the jet type, 10 inches by 18 inches by 18 inches, supplied by the Warren Steam Pump Company, and a closed heater placed in the hold with the pumps capable of taking care of all the auxiliaries. The piping throughout is arranged according to the best marine practice.

The hoisting machine arranged for lifting the spuds and ladder and for swinging the hull is of the 5-drum type with double engines having cylinders 8 inches in diameter and 8 inches stroke, built for a full boiler pressure of 175 pounds. The ladder is of solid I-beam construction, having a steel cutter of the open type driven by a double engine 9 inches by 9 inches. The cutter shaft is of nickel steel 5 inches diameter, while the gears are of manganese steel. The A-frames for lifting the spuds,

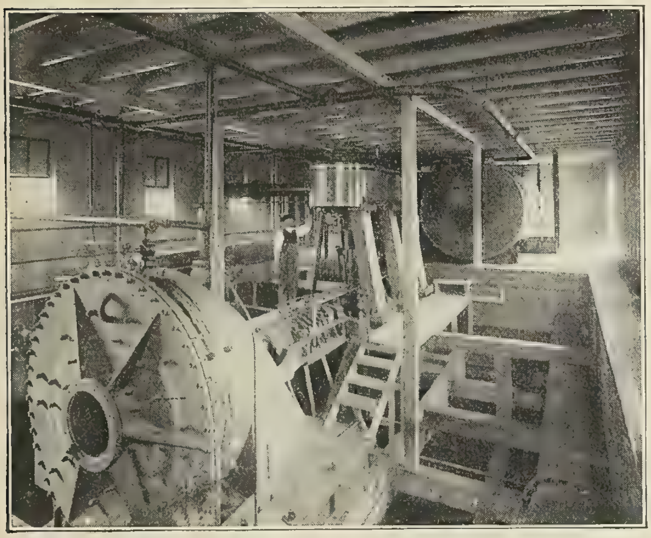


Fig. 2.—Jennings Centrifugal Pump

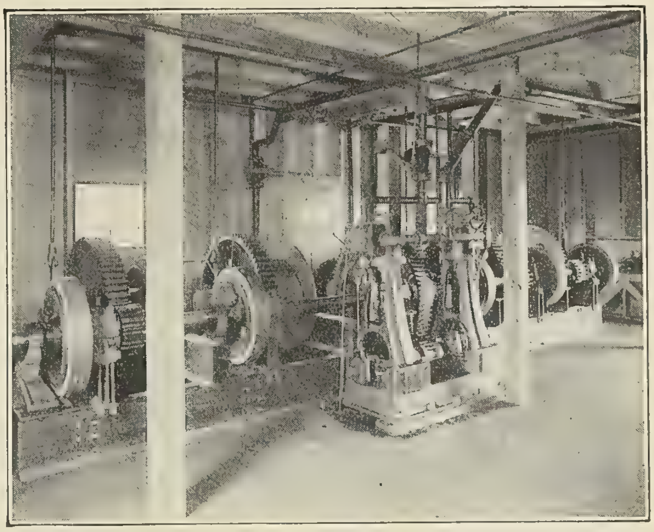


Fig. 4.—Hoisting Machinery

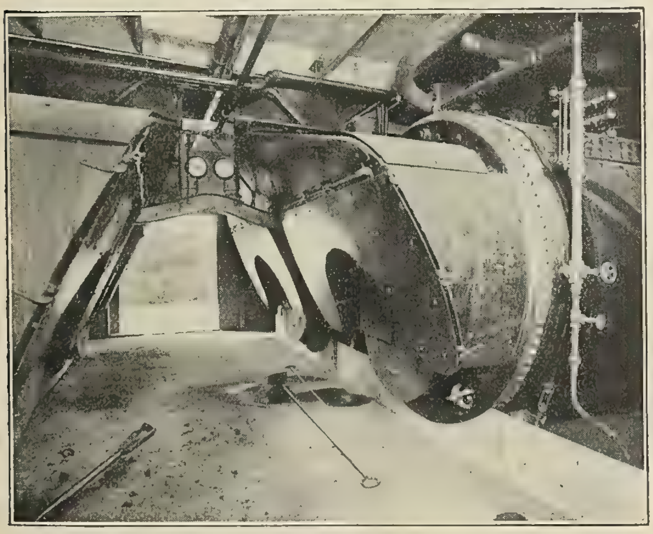


Fig. 3.—Boilers

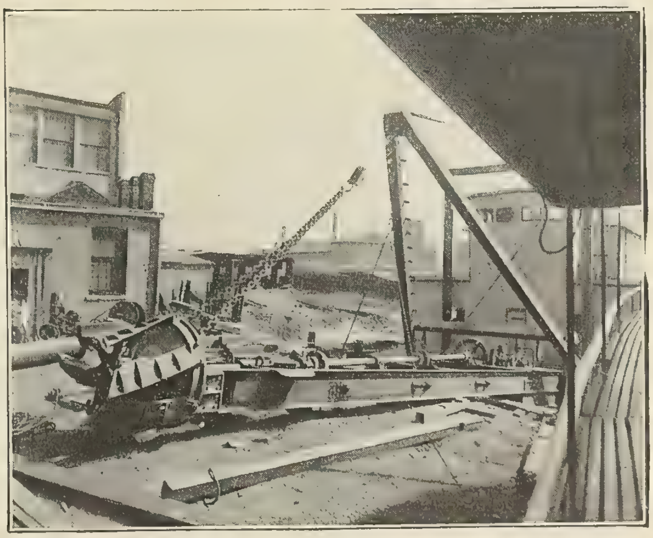


Fig. 5.—Cutter

the ladder, and also the gantry frames, are of wood. All the hoisting machinery is arranged to be operated from the upper deck, where the usual gages, such as the recording, vacuum and steam gages, are in full view of the operator.

Devotion of a German Marine Engineer to the Machinery in His Charge

The *Pall Mall Gazette* of London, in its issue of September 11, 1914, published an article entitled "Ober-Ingenieur McAndrews," which tells of the capture of the German steamer *Kronprinzessin Cecilie*. The extract given below relates to the devotion of the German chief engineer to his machinery, and of his effort to have it cared for after he should be gone. The references will be entirely clear to all who have read Kipling's fine poem about marine machinery, entitled "McAndrews' Hymn."

"But the *Kronprinzessin* had one true heart aboard, and here comes a fine touch of humanity. After making the round of the ship our chief engineer found in the cabin assigned him a blotting pad with a farewell message. There were none of the German jeers you might expect, but penciled appeals in broken English to clean the engines 'twice weekly,' to feed the 'pidgons' on the 'upper deck,' and to 'oel' the piston-rods regularly for the very good reason that 'paking is cast iron and will be rosting.' It seems that the Ober-Ingenieur who wrote this note had superintended the building of the ship in the Stettin yards, and when he took leave of her at Falmouth they say he sobbed like a woman bereft of a child. Doubtless in the Babylonian captivity of Bodmin he wonders how the engines that he loved are faring, and it should comfort him to know that they are in good hands. Moreover, his blotting pad message now adorns a British officer's album as so much proof that a true McAndrews may bear a German name."

The New United States Revenue Cutters

In accordance with a recent act of Congress authorizing the construction of two new ships for the Revenue Cutter Service, designs were prepared by the Treasury Department for the new ships; one to be known during construction as No. 26, to replace the revenue cutter *Woodbury*, stationed at Portland, Me., and the other as No. 27, to replace the old cutter *Winona*, now stationed at Mobile, Ala. Bids were opened at the Treasury Department on September 1 for the construction of these two vessels, and the lowest bid, that of the Newport News Shipbuilding & Dry Dock Company, in the sum of $198,000 (£40,600) for each vessel, was accepted, and the contracts have been formally awarded to that concern. Both vessels are of the same size, the only difference being that the cutter for service on the coast of Maine will be especially fitted for breaking ice in the frozen harbors and thoroughfares of the Maine coast during the winter season. The vessels will be built of steel throughout and will be fitted with every modern means of rendering aid to vessels in distress, of destroying derelicts and for the the other purposes of the Revenue Cutter Service.

Each vessel will be 165 feet 6 inches long overall, 150 feet long between perpendiculars, 32 feet beam molded, with a depth of 20 feet 9 inches. Their displacement at a mean draft of 11 feet 6 inches, with 200 tons of coal, 13,000 gallons of fresh water and 12 tons of stores, will be 900 tons. They will be flush-decked and schooner-rigged. Ample and comfortable quarters for a crew of about 60 men and 8 officers will be provided.

Powerful radio apparatus will be fitted to each vessel, as that is found to be indispensable for the regular work of the Service. The equipment will also comprise five able boats, a steam steering engine, a steam windlass, steam capstans for handling towing lines, and various other auxiliaries to make them first-class revenue cutters in every respect.

The propelling machinery will consist of one triple-expansion engine 17 inches by 27 inches by 44 inches by 30 inches stroke. Under maximum conditions the indicated horsepower will be about 1,000. Steam will be furnished by two straight tube watertube boilers, working at 180 pounds steam pressure. Powerful fire pumps and wrecking siphons will be fitted to each vessel to fit them for rescue work.

Since the contract has been awarded, as it was found that there was a sufficient fund left from the original appropriation, arrangements have been made to fit the Southern vessel as an oil fuel burner. She will carry sufficient fuel oil to give her a steaming radius of over 5,000 miles. This is a necessary feature of this vessel, as she will be employed in long cruises in the Gulf of Mexico searching for derelicts.

The contract calls for these vessels to be finished within ten months, and the active work of construction has already commenced at the yards of the builders.

Remarkable Accident to Shallow Draft Steamer on South American River

The stern-wheel steamer *F. Perez Rosa*, built by James Rees & Sons Company, of Pittsburg, Pa., for service on the Magdalena River, Colombia, South America, recently met with an unusual accident in coming down the river with about 200 tons of cargo, mostly coffee, on board and towing four barges. The boat is 170 feet long on the

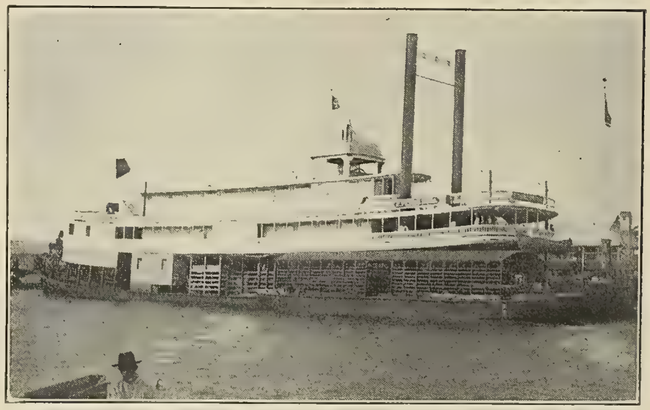


Fig. 1.—The *F. Perez Rosa*

deck, 32 feet beam, and draws 4 feet of water when loaded with 400 tons of cargo.

At the time of the accident the boat was struck on the port side about two feet below the waterline at frame No. 7 forward of the collision bulkhead by a submerged log about 5 feet in diameter. The bottom of the boat was ripped apart back to frame No. 36, tearing out the forward cross bulkheads at frames 10 and 30 and the center longitudinal bulkhead from frame 10 to frame 36. The damaged part of the hull was directly under the three boilers, which were left without support except for the deck beams. Fortunately, however, the cross bulkhead at frame 42 and the longitudinal wing bulkheads held, thus saving the boat.

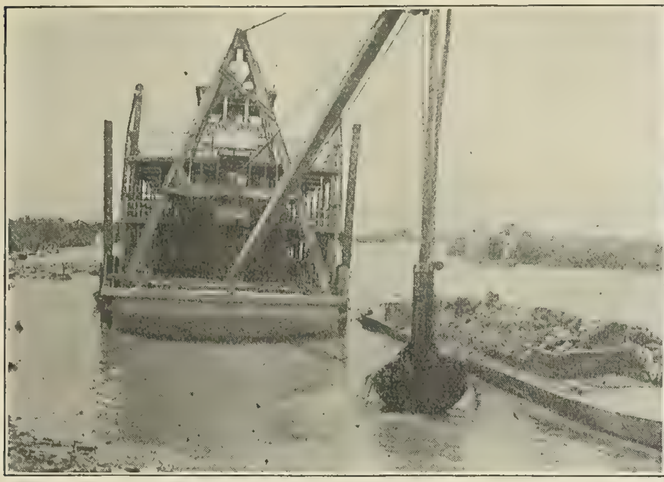


Fig. 2.—Dredging Out the "Mud Dock"

Fig. 3.—Entrance to the Pond

The cargo was thrown overboard and the boat was brought down to Barranquilla, a distance of about 500 miles, under her own steam. As no dry dock was available, a pond or mud dock was dredged out on one side of the river, and the boat was drawn into the pond, after which the dredge filled up the entrance behind the boat, and then the water was slowly pumped out. Blocks and shores were placed under the boat to enable repairs to be made. When the water was all pumped out of the mud dock, about 4 feet of soft mud was taken out, and

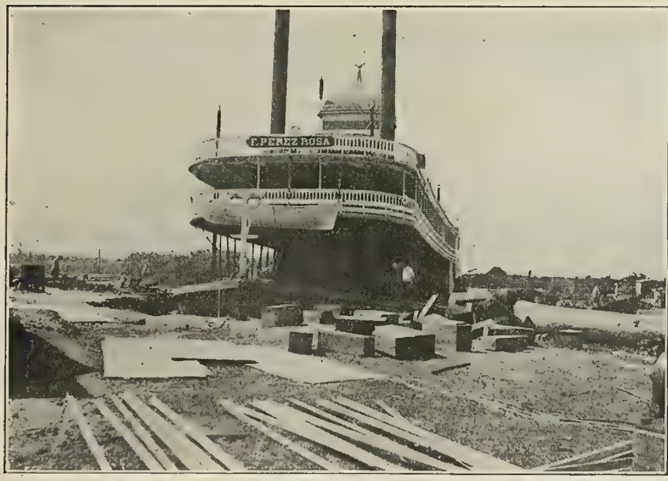


Fig. 4.—View of Boat in the "Mud Dock"

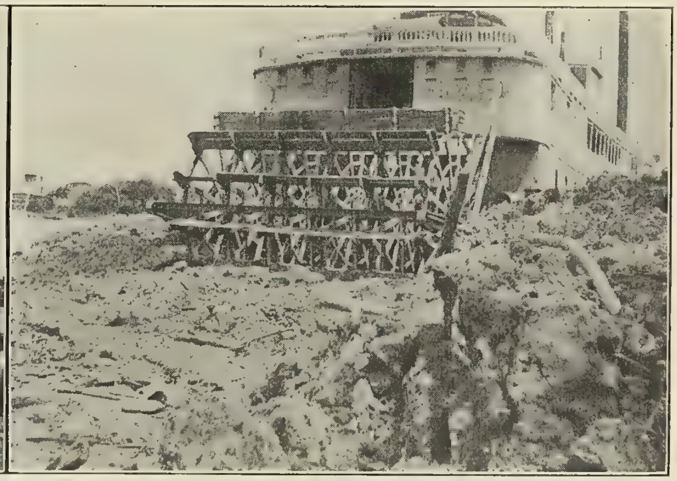


Fig. 5.—Mud Dam at Entrance to Dock

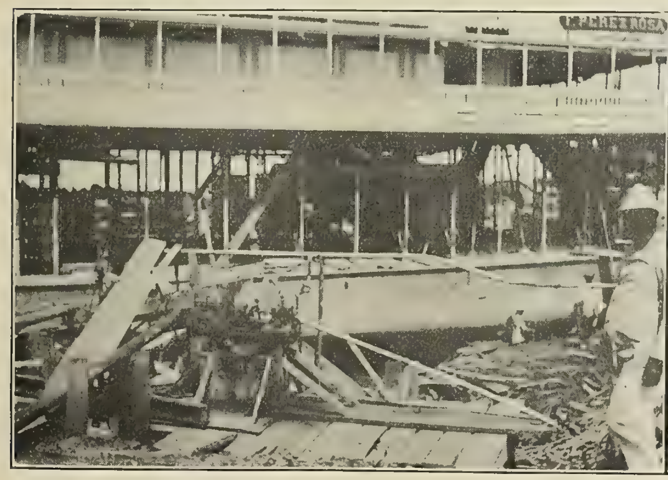


Fig. 6.—Digging Out the Mud after Pumping Out the Water

Fig. 7.—Interior of Damaged Hull, Looking Forward

then new plates were put in. It was necessary to keep the pumps working day and night, as the ground was soft and there was a lot of seepage.

About twenty-five days were required in preparation for the repair work, and fifteen days for making the actual repairs to the hull. The work was successfully accomplished, however, and the boat placed back in service. The entire job was carried out under the direction of Captain B. L. Wooster, marine superintendent of the steamboat company, to whom we are indebted for the photographs and details given above, and from whom readers can obtain further particulars, if desired.

Stern-Wheel Steamers for South America

Two Large Passenger and Freight Boats Built by James Rees & Sons Company for Service on South American Rivers

During the last year James Rees & Sons Company, Pittsburg, Pa., delivered to South American owners for river service two large stern-wheel passenger and freight boats of the type familiar on the western rivers of the United States. The first of these, the steamer *Palmer,* is 136 feet long on the main deck, 30 feet beam and 5 feet depth of hold, with 30 inches sheer. The framing of the hull consists of 2-inch by 2½-inch by 5/16-inch angles spaced 18 inches between centers. The deck beams are 2-inch by 3-inch by 5/16-inch angles, one-third of which are spaced 18 inches between centers and the balance spaced 3 feet apart. The stem is of forged steel, 1½ inches by 8 inches, and 5 inches slotted out to receive the keel plate, to which it is secured by countersunk tap bolts. There are five transverse bulkheads, which, together with the longitudinal bulkheads, divide the hull into twenty-one watertight compartments. The shell plating is of 7.5-pound plate, while the main deck is of ⅛-inch plate. All the plating is galvanized and double riveted. The hull is further strengthened by four Z-bar keelsons, together with stanchions spaced every 6 feet.

The cabin on the boiler deck has ten rooms besides the pantry and toilets, while on the hurricane deck there is a texas with the captain's room and eight rooms for the cabin crew. The galley and storeroom are on the main deck.

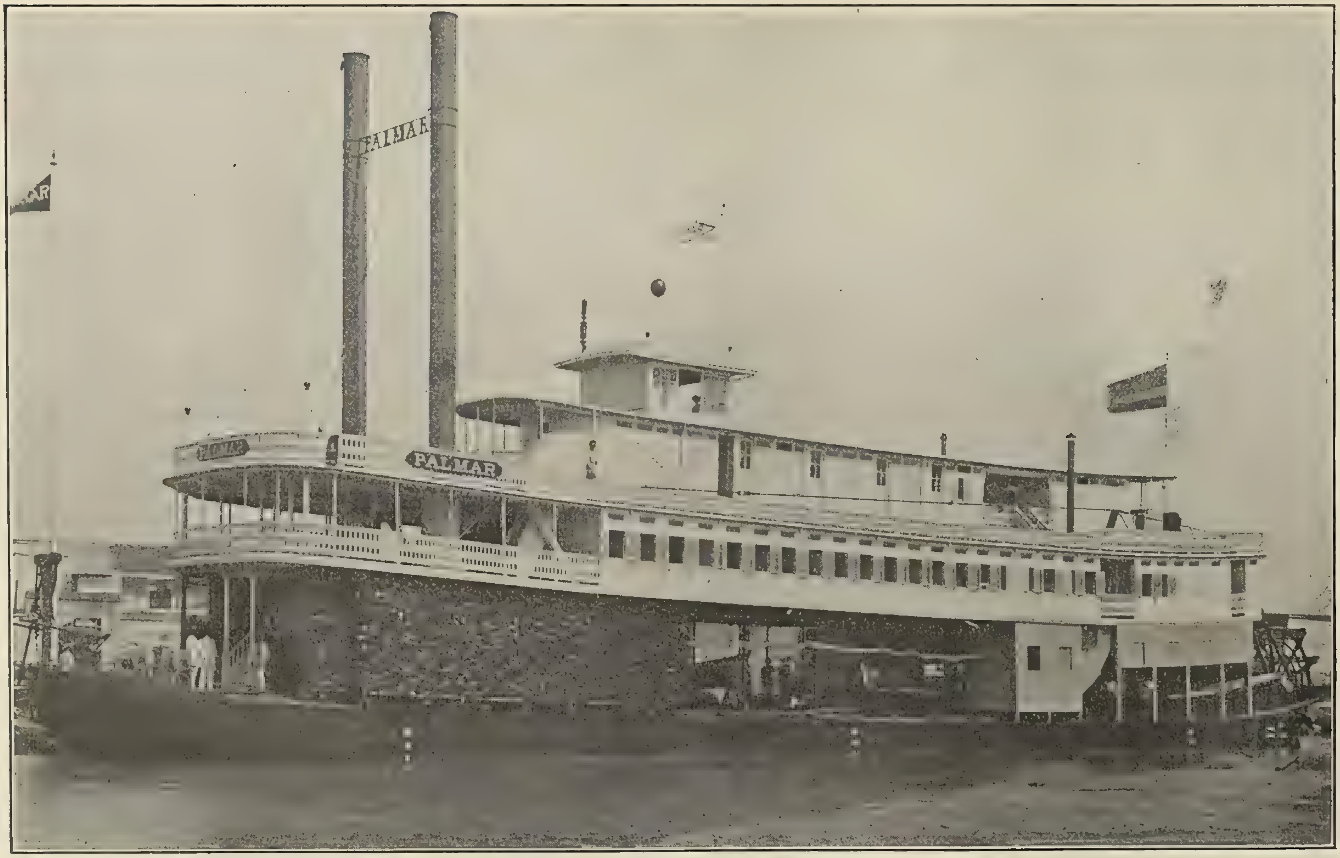
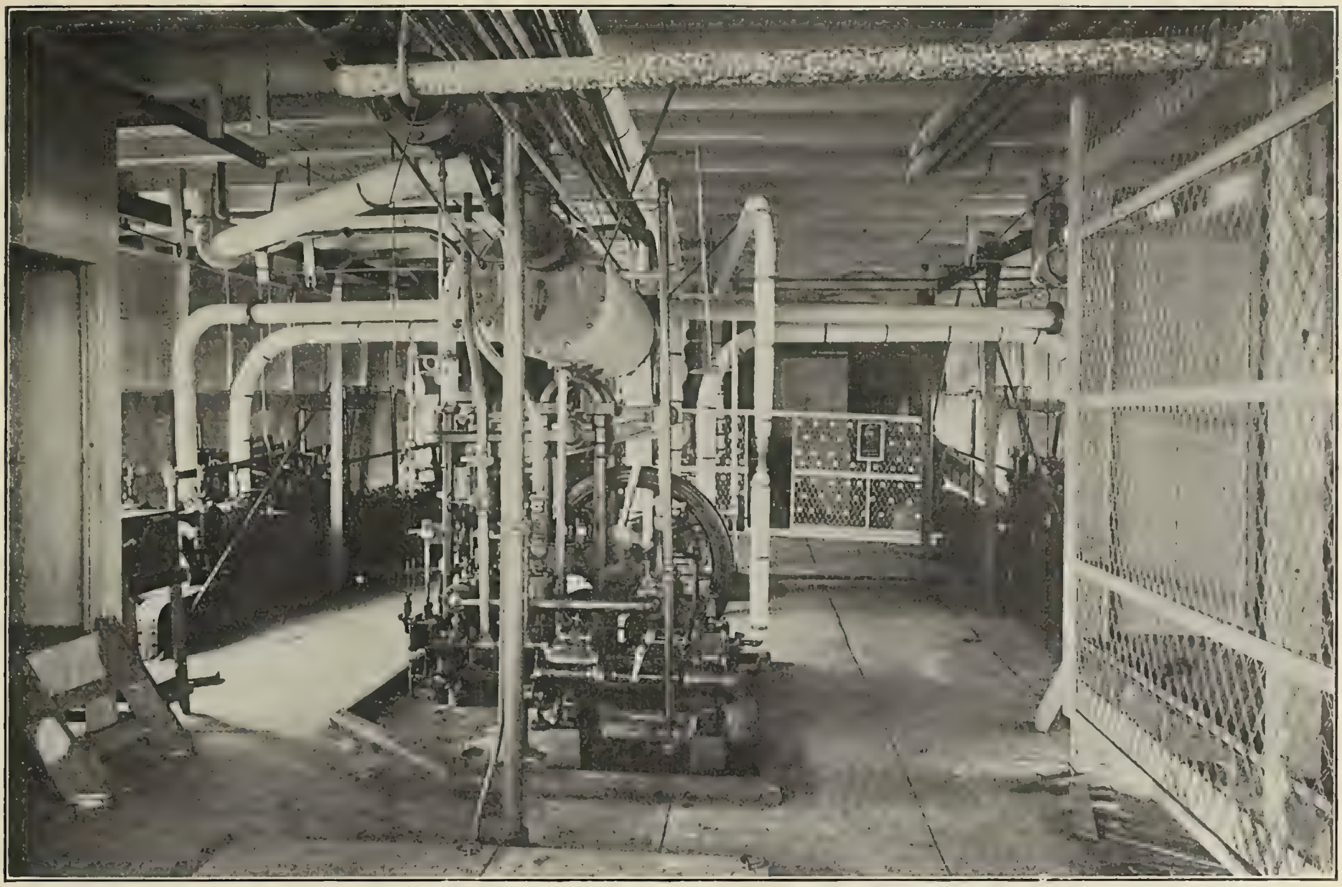
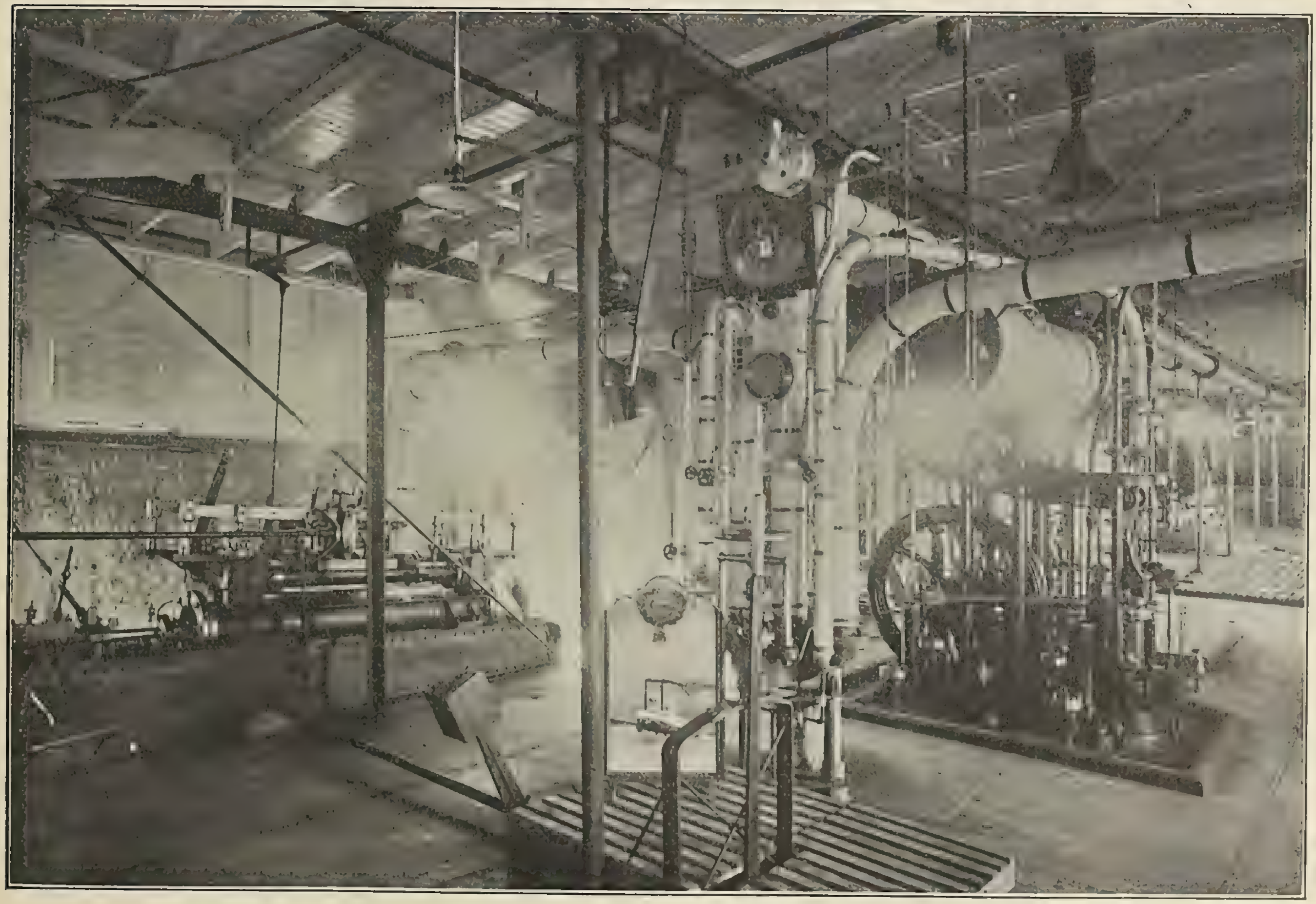


Fig. 1.—Stern-Wheel Passenger and Freight Steamer *Palmer*

Propulsion is by high-pressure engines with cylinders 14 inches in diameter, and a stroke of 6 feet, of the lever-balance poppet valve type, with inside cam motion on the connecting rod and adjustable cut-off motion from the crosshead. The stern wheel is 18 feet diameter with buckets 24 feet long and 22 inches wide. Steam is furnished at 200 pounds pressure by two horizontal tubular boilers built in accordance with the United States Steamboat Inspection Service Rules.

The second boat built for South American river service is the steamer *Bucaramanga,* 170 feet long on the main deck, 33 feet beam, and 4 feet 6 inches depth of





Figs. 2 and 3.—Views of the Engine Room of the Steamer *Palmer*, Showing Main Engines, "Doctor" Feed Pump and Operating Platform

hold with 3 feet sheer forward. The hull is divided into twenty-one watertight compartments by three longitudinal bulkheads of No. 10 gage plating and three transverse bulkheads. The main deck is of 3/16-inch steel plate, both the shell plating and deck being galvanized and punched for double riveting. The framing of the hull is of 2-inch by 3-inch by 5/16-inch angles spaced 18 inches apart, and the deck beams 2-inch by 3-inch by 5/16-inch angles spaced 18 inches apart for one-half the length of the boat, the balance being spaced 3 feet apart, all of the deck beams being secured to the side frames by gusset plates. Stringers of steel channels are secured to the floor frames and deck beams.

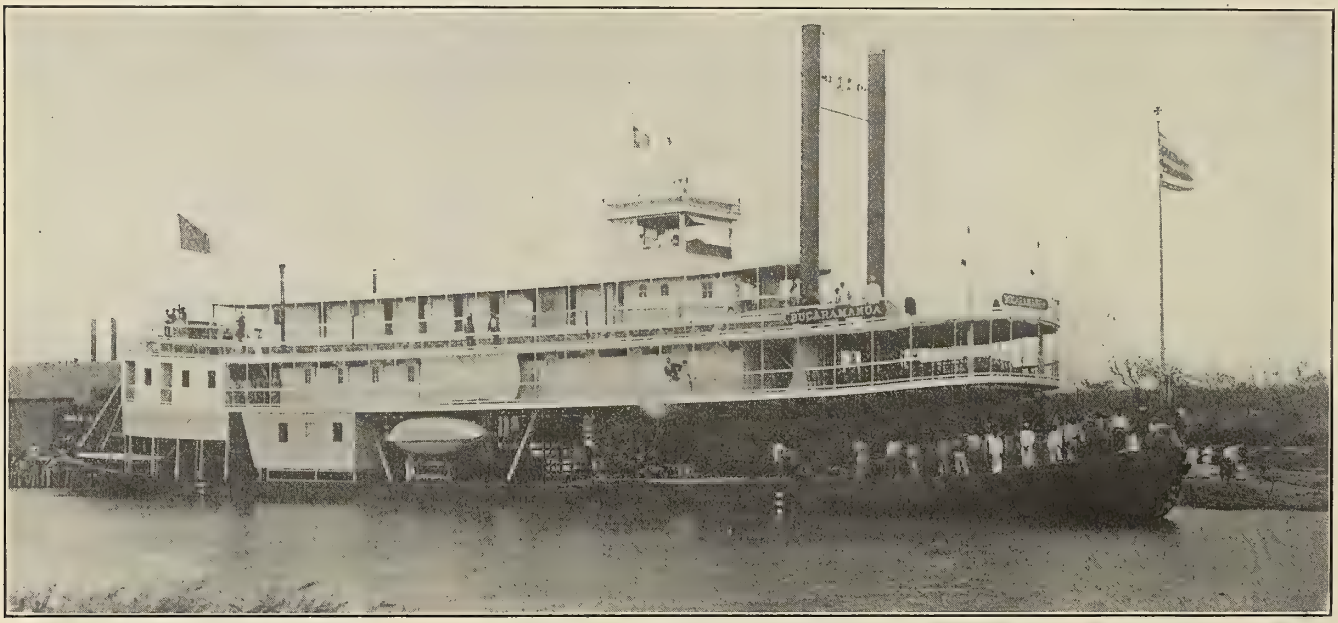


Fig. 4.—Steamer *Bucaramanga*

Fig. 5.—Main Cabin of Steamer *Palmer*

A large cabin is built on the boiler deck with rooms for passengers. while on the hurricane deck is a large texas for the crew and passengers with a pilot house on top of same. The ventilators throughout the boat are screened with bronze wire screen as a protection from mosquitoes.

The power plant consists of three tubular boilers, built for a working pressure of 200 pounds per square inch, and high-pressure engines, 16 inches in diameter, with a stroke of 6 feet, of the lever double balance poppet valve type, with the Rees inside full-stroke cam motion taken from the connecting rod and the Rees adjustable cut-off taken from the crosshead. The auxiliaries include a steam reversing jack, a "doctor" feed pump, a feed water heater, injector and the usual pumps.

After making several trips on the river, the boat has proved very successful during low water and has been able to tow four barges besides carrying freight and passengers on the boat itself.

Naval Architects' Annual Meeting

The twenty-second general meeting of the Society of Naval Architects and Marine Engineers will be held in the Engineering Societies Building, 29 West Thirty-ninth street, New York City, Thursday and Friday, December 10 and 11, and will begin at 10 A. M. each day. The annual banquet will be held in the Astor Gallery of the Waldorf-Astoria Hotel, at 7 P. M., Friday, December 11.

The following is a preliminary list of papers which have been promised, but as some of the manuscripts have not been received or passed upon by the committee on papers, a final list of papers actually to be published will be sent out before the meeting:

"International Conference on Safety at Sea," by Hon. E. T. Chamberlin.

"Some Experiments with Models Having Radical Variations of After Sections," by Naval Constructor D. W. Taylor, U. S. N.

"Expansion and Contraction of Certain Dimensions and Their Effect upon Resistance," by Professor H. C. Sadler.

Subject not yet decided upon. By Naval Constructor J. G. Tawresey, U. S. N.

"Stability of Vessels as Affected by Damage Due to Collision," by Mr. William Gatewood.

"The Application of Electric Propulsion to Battleships, together with the Experience Gained in the Jupiter," by Lieutenant S. M. Robinson, U. S. N.

"The Automatic Tension Engine, a New Marine Implement," by Mr. Spencer Miller.

"Subdivision Rules as Adopted by International Conference on Safety at Sea," by Mr. James Donald.

"The Present Status of Marine Diesel Engine Installations," by Mr. W. R. Haynie.

"The Thermodynamics of the Marine Oil Engine," by Mr. John F. Wentworth.

"The Behavior of Riveted Joints under Stresses," by Mr. James E. Howard.

"Recent Developments in Submarine Signaling," by Mr. J. B. Millet.

"Fire Protection of Ships," by Mr. W. C. Teague.

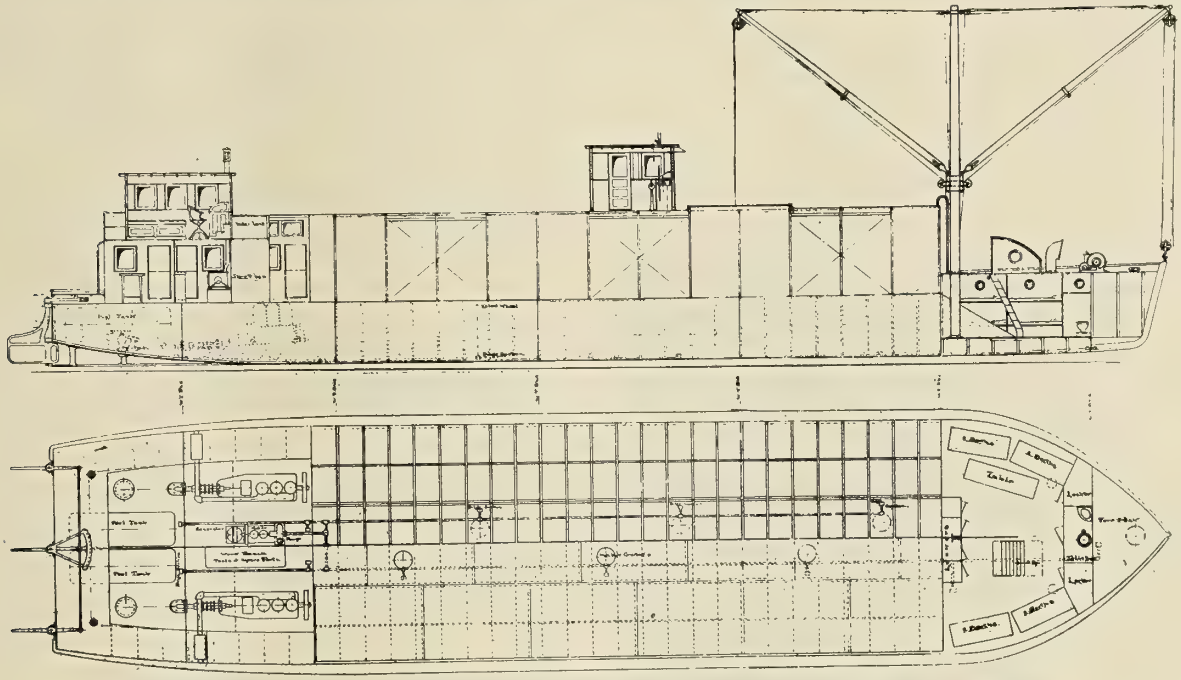
Twin-Screw, Tunnel Stern, Shallow-Draft Steel Cargo Boats for the Macon-Atlantic Navigation Company

An interesting item of much interest to those who follow the development of motor boating along commercial lines is the contract recently awarded to J. Murray Watts, of Philadelphia, Pa., by the Macon-Atlantic Navigation Company, Macon, Ga., for the designs and specifications of a fleet of ten steel cargo boats, of the twin screw, tunnel-stern type, plying on the Ocmulgee and Altamaha rivers between Macon and Brunswick, a round trip of 720 miles. These boats are propelled by two 50 horsepower oil engines and a 12 horsepower auxiliary oil engine runs the pumping plant and the generator. This generator supplies current for lighting the boat throughout, and for a 3,000 candle-power searchlight. There is, moreover, an electric winch located forward which is driven by a 10 horsepower electric motor. This winch is used for four purposes: first, for loading and unloading cargo which cannot be conveniently handled through the side doors of the freight compartment; second, by means of the forward derrick, lifting snags or other obstructions from the channel; third, warping the boat alongside of dock, and fourth, handling the anchors.

The navigation of the rivers between Macon and Brunswick is very difficult in the dry season on account of the numerous sand bars, which stop navigation for all but the lightest draft boats, and another difficulty is the fact that in the upper reaches of the river the channel makes very sudden bends, so that it has forced the old-time, sternwheel steamers to get lines ashore and warp their way around the bends. During the rainy season there is generally plenty of water in the river, often as much as 10 to 12 feet over the worst shoals, but after a prolonged drought there is found to be only a little over 3 feet on these shoals. For this reason the company required boats which would carry a minimum of 75 tons of cotton on a draft of 30 inches and 150 tons of cotton on a draft of 45 inches.

The design of the tunnels in which the screws are located has been very carefully studied out, so that there will be no tendency to suck the stern down, even in the shoalest waters. To aid in making the sharp turns in the upper reaches of the river, each boat is equipped with three rudders, which, together with the reversing twin screw engines, give the boats ample maneuvering power.

The hulls of these vessels are built of mild steel and divided into twelve watertight compartments, each compartment being fitted with a manhole for inspection purposes and a valve wheel operating the bilge suction, so that, should the bottom be damaged by contact with a shoal, the rotary 12 horsepower bilge pump will be quickly connected up and keep the water in that compartment down until repairs can be made. This pump is also used for washing down decks and as a fire pump. It will be noted that there is a watertight athwartship bulkhead which divides the engine room into two separate compartments, so that, should one of these compartments be flooded, the boat will still have an engine to run on. Moreover, there is a bulkhead between the engine room and the after peak, so that should damage occur to the tunnel, as jamming or obstructions between the propeller blades and the tunnel walls, the water will not flow into the engine room. The fuel tanks are also placed in the after peak and protected by this watertight bulkhead from any accident or fire in the engine room.



Design of Self-Propelled, Tunnel-Stern Cargo Boat for the Macon-Atlantic Navigation Company

To obviate the danger of fire, the entire boat, including hull and house, is made of steel, the only woodwork being the captain's cabin and the pilot house.

The accommodations are unusually good for a boat of this type, there being a roomy forecastle, with bunks for eight men, with the usual lockers, toilet room, etc. Aft there is a stateroom for the captain, a toilet, a stateroom for the mate and engineer, a dining room, galley and storeroom.

Junior Institution of Engineers.—The Most Hon. the Marquess of Graham, D. L., C. B., C. V. O., has been elected president of the Junior Institution of Engineers for the year 1914-1915. The Vickers prize, consisting of a gold medal and a premium of instruments or books, has been awarded to Mr. James Richardson for his paper on "High Power Diesel Engines; Their Development for Marine Service."

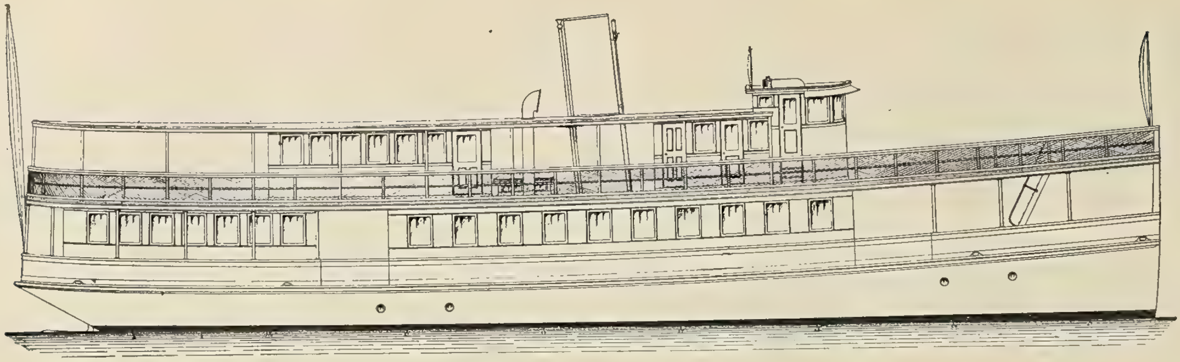


Fig. 1.—Outboard Profile of the *Dixie*

New Shallow Draft Passenger Steamer for Use in Florida

Messrs. Cox & Stevens, naval architects, New York City, have recently placed a contract with William R. Osborn & Son, of Croton-on-Hudson, N. Y., for the construction of a shallow draft combination freight and passenger vessel, named the *Dixie,* to be operated by the Kinzie Brothers Steamboat Line, Fort Myers, Fla. This line operates vessels from Fort Myers down the Caloosahatchee River to the Gulf of Mexico, a distance of eighteen miles. The boats carry passengers and farm truck and therefore require a fair rate of speed on shallow draft with ample deck space and storage room for vegetables. The principal dimensions of the *Dixie* are: Length, 100 feet; beam, outside planking, 20 feet; draft, 4 feet 2 inches.

The boat has pleasing and serviceable lines, the freeboard is moderate, the sheer ample, and the general construction and disposition of deck houses, pilot house, etc., practical and attractive.

On the main deck aft is a ladies' saloon 22 feet in length, on each side of which is a passage for handling lines, etc. Just forward of this saloon is a clear space directly across the deck, from which the companion stairs lead to the upper deck. Forward of this space, which serves as the main gangway, is a central deck house containing the machinery inclosures, galley, messroom and a separate saloon for colored passengers. The central deck house is 40 feet long, leaving a clear space forward on the main deck 27 feet long for freight. There is also a clear space for freight 5 feet wide on each side of the deck house. The hold space, both forward and aft of the machinery, is ceiled and available for the stowage of cargo.

Above the main deck there is a complete upper deck running from one end of the vessel to the other for the

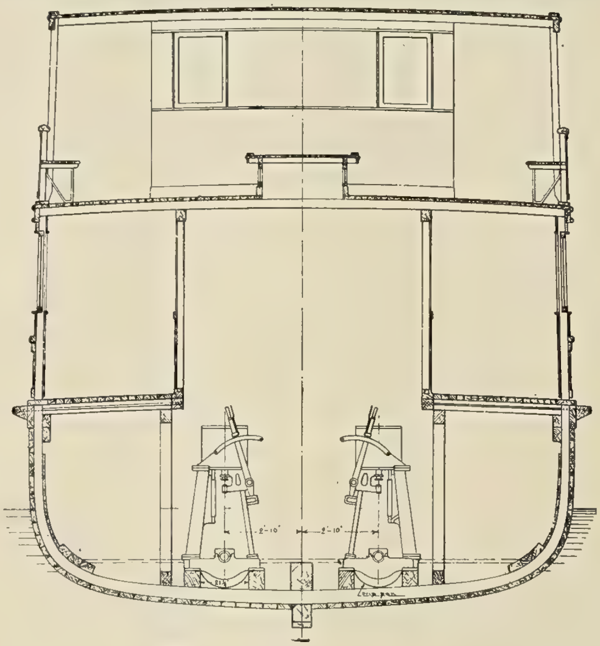


Fig. 3.—Midship Section

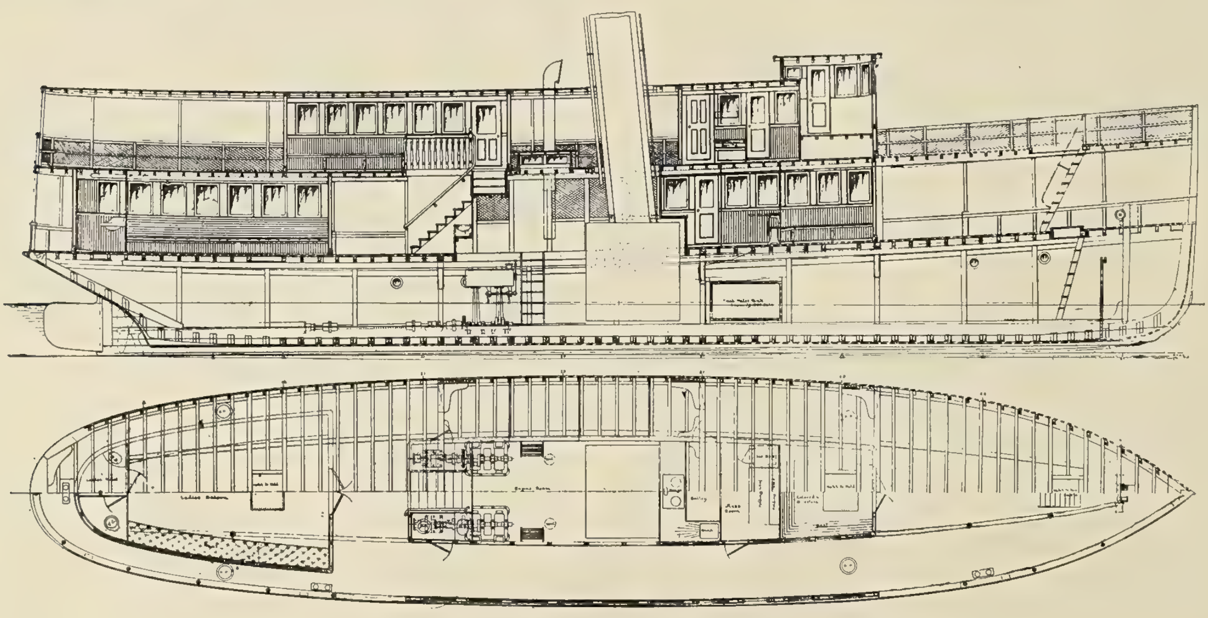


Fig. 2.—Construction Plans of the *Dixie*

accommodation of passengers. A deck house, 20 feet by 10 feet, provides shelter in stormy weather, and also houses in the companion stairs to the lower deck.

As the requirements of the traffic for which the boat is designed demand a speed of twelve miles per hour loaded on a shallow draft, twin screws were adopted, driven by fore-and-aft compound direct-acting engines with cylinders 7½ inches and 16 inches diameter by 10 inches stroke. Steam is supplied by a watertube boiler arranged to burn wood, as wood is the only fuel that can be used economically in the region where the boat is to operate. There is a complete outfit of auxiliaries, including two feed pumps, a bilge pump, fire pump, engine room signals and a complete electric lighting plant.

According to the contract, the *Dixie* will be turned over to her owners not later than December 1, and she will then proceed to Florida to take up active operations in carrying fruit and passengers.

Stern-Wheel Motor Boat Tabasquena

Nowhere is the question of providing a maximum carrying capacity on a minimum draft of more importance than in the design of the freight and passenger boats used on the rivers of Mexico. Many of these streams, while they may have fair depth for most of their length, are full of sand bars which are constantly changing, and to provide against this a type of stern paddle wheel boat powered with either gasolene (petrol) or kerosene (paraffin) engines is being used with great success. This type is illustrated by the *Tabasquena,* recently designed and built by Percy Stout, Frontera, Tab. Mexico, and now in successful operation on a freight and passenger run of several hundred miles.

The *Tabasquena* is 60 feet in length overall and 50 feet at the waterline. Her beam is 12 feet 7 inches overall

The *Tabasquena*

and the molded beam 12 feet. Her shoal draft is 2 feet 9 inches, while her running draft is only 22 inches forward and 18 inches aft. The block coefficient at the working draft is .66 and the displacement approximately 20½ tons.

The power plant consists of a six-cylinder 60-70 horsepower "Buffalo" heavy duty engine, built by the Buffalo Gasolene Motor Company, Buffalo, N. Y., equipped with high tension ignition and an air starter. The transmission is by bevel gears running in an oil-tight case and chain and sprockets, the ratio of reduction being 13.3 to 1.

The paddle wheel is a ten-armed wheel split, making 30 buckets 11 inches by 44 inches pitched 18 inches. The diameter outside of the wheel is 8 feet 6 inches and operates at a normal speed of 35 revolutions per minute, the dip on running draft being 14 inches.

The fuel is carried in two tanks below decks in a sealed compartment. These tanks have a capacity of 400 gallons, which gives the engine fuel for 50 hours' continuous running at full speed.

The boat has a normal speed of about 12 miles per hour. On her trial trip of 21 miles she towed a 93-foot by 33-foot barge and two 90-foot by 20-foot barges, and easily handled the tow against a 3½-mile current, making the trip in five hours flat. When the engine is turning 375 revolutions per minute there is a fuel consumption of 7 gallons per hour, and at full speed, or 500 revolutions per minute, the fuel consumption is 7.6 gallons.

Producer Gas Freight Boat

The freight boat *Smyrna,* which is 65 feet long and 19 feet beam, runs between Smyrna, Del., and Philadelphia, Pa., and other neighboring ports. It has a capacity of 75 tons of freight and is equipped with a 65-horsepower

Freight Boat *Smyrna*

Wolverine engine and a suction gas producer plant manufactured by A. L. Galusha & Company, Boston, Mass. With this equipment the boat is enabled to carry a 75-ton cargo 62 miles on a consumption of one dollar's worth of fuel. The boat's regular run from Smyrna to Philadelphia is 62 miles, and the trip is made on an average of 6½ hours with a coal consumption of 432 pounds, which is less than one pound per horsepower hour. The coal used costs from $4 to $5 (16/8 to 1/0/10) per ton, which, with this plant, is as cheap as gasolene (petrol) or other oil fuel at 2 cents (0/1) a gallon. As compared with competing boats, the fuel bill of the *Smyrna* is only one-tenth of that of her competitors.

Oil Engines for Chinese River Boats

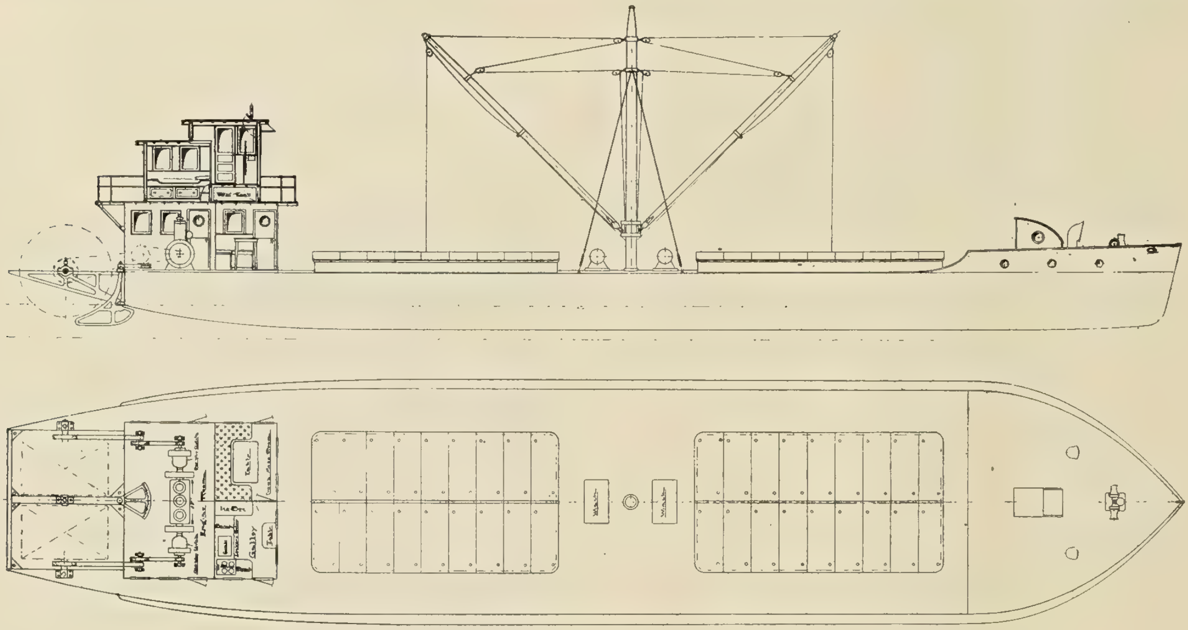
Two semi-Diesel oil engines have been supplied by R. Wilson & Sons, South Shields, for two Chinese vessels, to be used for general cargo and passenger service on the river at Hong Kong. The engines are of 72 and 84 brake horsepower, while two other engines of 180 and 105 brake horsepower are ready for shipment by the same firm. The larger engines have four and three cylinders, respectively, and are directly reversible by compressed air. While these engines are of the semi-Diesel type, there are no hot bulbs or water drips.

Motor-Driven Stern-Wheel Boat

The accompanying plans show a boat recently designed by J. Murray Watts, of Philadelphia, Pa., which will be one of a fleet to be operated between Galveston and Corpus Christi, Texas. These boats are built of mild steel of 10.2 pounds plating and are absolutely fireproof, the only wood used being in the pilot house. The dimensions are 110 feet by 24 feet by 6 feet. The cargo is carried in the hold and is loaded and unloaded by means of two power winches and two derricks through two large hatches. On a draft of 45 inches 150 tons can be carried and 200 tons if the depth of navigable water allows for further immersion.

The general appearance of the boat is similar to that used in most South American and gulf waters. The crew is quartered forward in an airy, raised-deck forecastle with very comfortable accommodations. There is a deck house built aft, and on top of this deck house are the captain's stateroom, toilet room and the pilot house. The main deck house contains the engine room, the crew's mess room and the galley.

The greatest interest centers on the adaptation of the stern wheel to the propulsion of these power boats. As the stern-wheeler is notoriously hard to handle in narrow channels, the following arrangement has been adopted as the best after a long experience with this class of boat: The main engine, a 100 horsepower motor burning cheap oil, is set up on heavy foundations athwartships, on the main deck, where it is as accessible as a stationary engine, and, like a stationary engine, it has a flywheel at each end of the crank case and a friction clutch connected to each flywheel. Through these friction clutches it drives a counter shaft with a Morse silent chain, giving a gear reduction of six to one. From this counter shaft runs a link belt chain to each paddle wheel (of which there are two). This double six to one gear, giving a total of twelve to one reduction, allows the main engine to run at 360 revolutions per minute and drives the paddle wheels at 30 revolutions per minute. The two paddle wheels are separated and so arranged that, when making a sharp turn, the inner paddle wheel can be declutched from the engine and drag, while the whole power of the engine speeds up to the outer paddle wheel, and so gives a very strong turning moment to the boat. These paddle wheels are of the feathering type, so that, in spite of the comparatively small diameter of 9 feet, they will have the efficiency of a very much larger diameter wheel on account of the buckets entering and leaving the water in practically a vertical line.



General Arrangement of 110-Foot Stern-Wheel Freighter

New United States Battleships California, Mississippi and Idaho

On October 6 bids were opened at the Navy Department, Washington, for the construction of three new battleships provided for by recent acts of Congress. As has been the policy of the Navy Department in previous years, bids could be submitted either wholly on the Department's plans and specifications, or on plans and specifications prepared by the contractor for the machinery, but on the Department's plans of hull and equipment. Four shipbuilding establishments submitted bids for the construction of the vessels, the lowest bidders being the New York Shipbuilding Company, of Camden, N. J., and the Newport News Shipbuilding & Dry Dock Company, of Newport News, Va. Each of these concerns offered to build one vessel within a specified time of thirty-six months.

As under the law one vessel must be built at a Government navy yard, the New York Navy Yard submitted an estimate to build one vessel for the sum of $7,155,300 (£1,457,000) on the Department's design for both hull and machinery, and another estimate of $6,992,859 (£1,433,000) for a vessel equipped with machinery for electric propulsion, the machinery of the latter type consisting essentially of turbine-driven generators furnishing electric current to motors driving the propeller shafts. The propositions of each of the other two bidders were substantially as follows:

1. The Newport News Shipbuilding & Dry Dock Company for one vessel to cost $7,115,000 (£1,456,000) on the Department's plans for hull and equipment, the engine installation to be turbines of the Curtis type. This installation has four shafts with separate high-pressure

ahead and astern turbines placed on the outboard shafts and a combined ahead and astern turbine on each of the inboard shafts. To the inboard shafts are also connected an arrangement of separate high- and low-pressure cruising turbines operating said shafts by means of reduction gear. The turbines are substantially the same as those used on the battleship *Pennsylvania,* now building by this company, but the arrangement differs in that the cruising turbines connecting with the main low-pressure turbine shaft are placed outboard in the latter.

2. The New York Shipbuilding Company for one vessel to cost $7,175,000 (£1,470,000) on the Department's plans for both hull, equipment and machinery. The engine installation of this ship has also four shafts, but the turbines are of the Parsons type. Independent ahead and astern turbines are placed on the outboard shafts and combined ahead and astern turbines on the inboard shafts. The cruising turbine outfit in this case consists of only one turbine connecting, by means of reduction gear, to each of the inboard shafts.

The boiler installation of both ships is made up of 12 boiler units placed in three separate boiler compartments, all of the boiler uptakes leading to one smokestack. All boilers are equipped for burning oil fuel, no provision being made for coal firing.

The general features of the ships are as follows: Displacement, 32,000 tons; speed, 21 knots; total shaft horsepower, 32,000; main battery, twelve 14-inch B. L. R. guns.

Greater Safety and Efficiency in Paneling and Ceiling Passenger Vessels

Referring to the deck paneling, stateroom bulkheading, wainscoting, door panels, etc., of the modern excursion and passenger steamer, a prominent builder of passenger vessels made the following remarks in the discussion of a paper read at the twentieth general meeting of the Society of Naval Architects and Marine Engineers:

"We know that the substitution of composite board and of the so-called 'Nevasplit' panels is far safer than the pine panels formerly used, which were much heavier and would ignite more quickly, and their adoption has been quite a great advancement in the line of safety."

This expresses, we believe, the general opinion of naval architects and shipbuilders of the United States, as well as of many prominent men on the other side who are to-day paying more attention to this particular feature of construction than ever before.

There are many good reasons why this should be so, for with paneling material of this sort there is no possibility of checking or splitting, a feature which alone makes for sanitary construction. It is claimed that there is practically no expansion or contraction to the material, while thickness for thickness its weight is about the same as white pine, but where a 1-inch panel of white pine should be used, a ⅜-inch panel of the above type is sufficient for all purposes of strength or general durability. This feature shows a great saving in weight and some economy of space.

As against the necessity of studding staterooms and bulkheads generally, paneling of this type is mostly made up into rabbeted or grooved forms of 1¼-inch material in the joiner shop, and the completed sections are brought aboard the ship ready to slide into the moldings or grooves made to receive them. This feature shows another very marked economy of space, time and weight, and a very important saving in hand labor, as the principal labor is covered by machine work in the shop.

This material has been responsible for a marked change in design of the paneling of wainscots, walls, decks and doors, in that ⅜-inch panels are commonly used as free floating panels, which are merely slipped into rabbeted or grooved forms, many of which are 4½ feet wide, or even wider, and running the full height of the bulkhead or wall. Doors are made by rabbeting or grooving a single panel into the stile, without the danger of shrinkage or rattling panels, which would have to be considered had we dared to employ such a large panel of wood for door panels on shipboard.

Another feature of this manufactured product is, that while it is not impervious to water, or the long-continued action of moisture, it is, when painted, entirely unaffected by moisture and continues to harden and become more resistant with age.

Naval architects, ship builders and owners have shown a real progressive spirit in meeting the manufacturers of products of this sort fairly, and giving them every opportunity to prove their claims in a desire that the shipping fraternity might obtain a suitable material preferable to the typical pine sheathing or wood veneer construction for this class of work, with the result that during the past few years many of the finest inland and coastwise steamers built in the United States have included material of this sort throughout, wherever practicable. Several of these vessels have been described at length in recent issues of this magazine, including the Hudson River Day Line steamer *Washington Irving,* illustrated and described in the July, 1913, issue; the Hudson River steamer *Berkshire,* of the Hudson Navigation Company (July, 1913), and the passenger and freight steamship *Congress,* of the Pacific Coast Company, also described in the July, 1913, issue.

Non-Inflammable Panels and Bulkheads

For several years manufacturers have persistently tried to produce a non-inflammable panel which would embody all the strength, hardness and water resistance of the regular material above described, and within the past year or two this has been accomplished to a certainty. One of the first ship builders of note to test carefully and take advantage of this material, was the firm of James Rees & Sons, Pittsburg, which built a light draft, all- steel boat* for Jones & Laughlin, of Pittsburgh, to run on the Ohio River. This boat has an all-steel hull and superstructure, excepting the non-inflammable "Nevasplit" door and bulkhead panels which went into cabin, saloon, passageways and staterooms.

Shortly afterward experiments were conducted by the Test Department of the Pennsylvania Railroad at Altoona, with a result that the reconstructed ferryboat *Pittsburgh* † was entirely sheathed with Nevasplit on the walls and decks of the vehicle gangways, which now constitute the entire main deck of this boat, some 20,000 feet of surface area. This material was adopted here for two reasons, namely, the impossibility of corrosion occurring on the back of the sheathing where it could not be painted after installation, and for its insulation value, retarding the transmission of the heat to the stanchions or carlines behind the sheathing, and in case of a sudden conflagration, which might be caused by an automobile or load of

* The *Aliquippa,* illustrated in this number.

† See October, 1914, issue of INTERNATIONAL MARINE ENGINEERING, page 433.

hay taking fire, would prevent the fire from burning the walls or ceiling and spreading to the passenger deck and pilot houses above.

It is not, we think, too much to prophesy that in view of the large quantity of the regular material described at length in the earlier paragraphs, ship builders and naval architects generally will pay very much more attention in the future to this question of non-inflammable paneling, which in the total outlay of the ship means a comparatively trifling increased cost over the regular material, say a matter of $1,000 (£205) or $2,000 (£410) in the total cost of the boat. Surely the fact that a fire of considerable seriousness would undoubtedly be confined to the stateroom or compartment in which it originated, for a very considerable time before spreading to other rooms, should, and does, warrant serious consideration of such a product.

Shallow Water Navigation in Distant Lands

BY A GLOBE TROTTER

Novel craft for shallow water navigation are to be found in many parts of the world, and particularly in tropical countries, where transportation on land is difficult on account of the forest jungles. Some interesting types of such craft are shown in the accompanying illustrations.

Fig. 1 is a view of the river boats at Barranquilla, the most important port of the Republic of Colombia, South America. Barranquilla is located on the left bank of the Magdalena River about seven miles from its mouth. Because of the dangerous bar at the mouth of the river, navigation is carried on by light draft steamboats, many of which are built in the United States and shipped in knock-down form for erection at Barranquilla. These boats are able to ascend the river as far as Yeguas, where goods are transshipped by rail to Honda and thence by pack animals to Begota or by still smaller boats further up the river. Curious covered barges, such as can be seen at the left in the foreground of the photograph, are used for passage over the bar at the mouth of the river.

Fig. 2.—Steamboat on Lake Valencia, Venezuela

In Fig. 2 is shown a small steamboat in use on Lake Valencia, Venezuela, South America. Although a small boat, the vessel can boast of an observation deck on top of the cabin. The photograph shows the boat landing at the island of El Burro (The Mule).

Fig. 1.—River Boats on the Magdalena River at Barranquilla, South America

In the harbor of Singapore, shown in Figs. 3 and 4, which is the most important port of the British Malaya, there are literally hundreds of small, curious, flat-bottom boats to be seen at all times. On account of the jungles and wilderness of the country, the Malays are averse to land transportation, and, consequently, make extensive use of these boats on the Singapore River. The boats are propelled by sail or by poling; the white covers over the boats are made of straw and are used to protect passen-

Fig. 3.—Flat-Bottomed Scows at the Mouth of the Singapore River

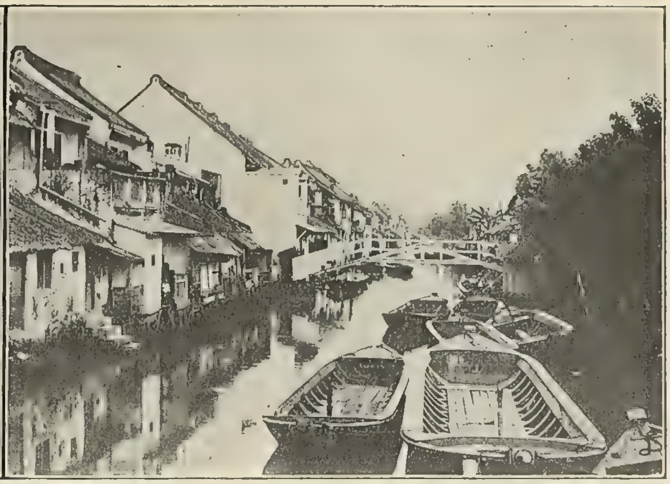


Fig. 5.—Canal Boats at Batavia, Java

Fig. 4.—Singapore Harbor, the Most Important Port of the British Malaya

Fig. 6.—Burmese Paddy Boat on the Irawaddy River

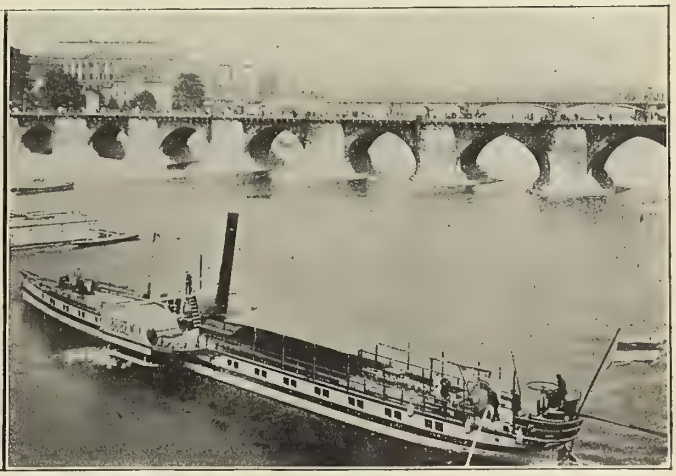


Fig. 7.—Side-Wheel Passenger Steamer on the Elbe River at Dresden, Germany

gers or cargo from the fierce heat of the tropical sun or the drenching downpour of the frequent torrential rain storms. At the mouth of the Singapore River larger flat-bottom scows are used, such as are shown in Fig. 4.

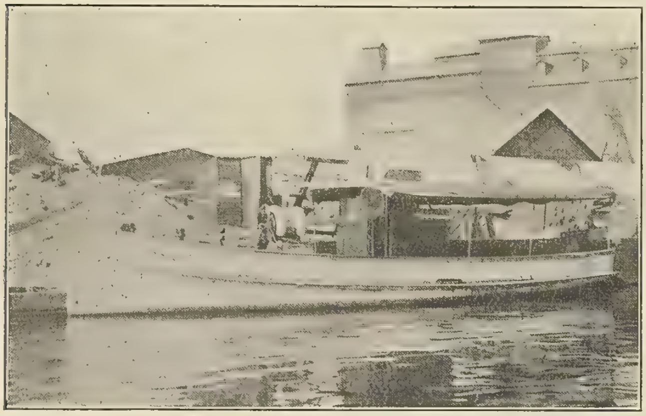
There are many canals in Java, and on all of these are found huge flat-bottom canal boats such as shown in Fig. 5. These boats are substantially built, and carry comparatively large cargoes. They are propelled by poling, or sometimes they are towed along from the bank. Fig. 5 shows a section of one of the canals in the city of Batavia, Java.

A different type of shallow draft boat is shown in Fig. 6. This is a typical Burmese paddy boat of the type that constantly plies up and down the Irawaddy River. An unusual feature of this boat is the crescent-shape spar, which is very slender and of the same length as the mast. The mast itself is double and consists of two spars lashed together. When under full sail before the wind, this boat has two large square mainsails, one on each side of the mast, and two small square topsails. Each paddy boat has a high poop deck, on which is a covered chair for the steersman, who steers the boat by means of a long tiller.

A more modern type of boat, which is capable of navigating extremely shallow waters, is shown in Fig. 7. It is a side-wheel steamer used for passenger traffic on the Elbe River at Dresden, Germany. So shallow is the river, and so short the turns, that a long pole is used at both the bow and stern to assist in turning the vessel. A man poling in the stern of the boat can plainly be seen in the photograph.

A Fisherman's Motor Boat

A 40-foot power boat, capable of a speed of seven miles per hour, is being used by Mr. Joseph Rapp, a fisherman of Erie, Pa., for daily runs averaging twenty-three miles

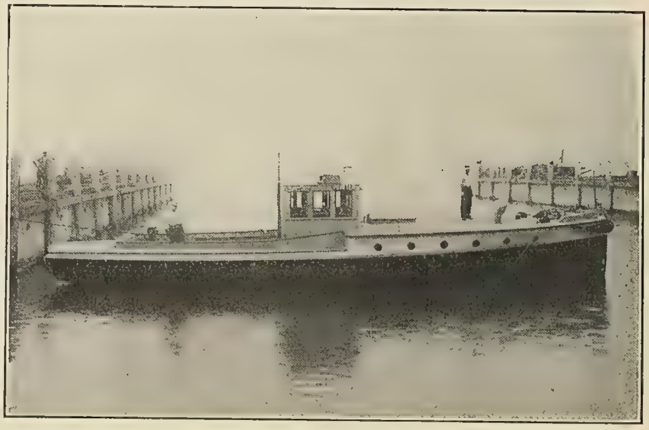


Fishing Boat *Crescent*

each day in the week. The boat is equipped with a 15 to 18 horsepower Fulton self-sparking engine, built by the Fulton Manufacturing Company, Erie, Pa., which turns a three-blade, 26-inch reversible propeller. The engine requires no batteries or coil.

Diesel-Engined Work Boat, Pointer of Baltimore

The Maryland Steel Company, Sparrows Point, Md., has recently placed in service for carrying freight and workmen in Baltimore harbor a 54-foot motor boat which is unique in that it is the first American boat to be fitted with a Diesel engine of American make and design of such small size as 50 horsepower. The motor is a three-cylinder engine with an 8-inch bore and 9-inch stroke rated at 50 horsepower when turning 400 revolutions per minute. The engine was designed and built by the Fulton Manufacturing Company, Erie, Pa., and on July 24 was given a thorough test in Baltimore harbor. The boat was run for a distance of 8.8 miles at a speed of 8.99 knots,



The *Pointer*

the engine running at 388.4 revolutions per minute. Although the builders guaranteed a consumption of only .55 pound of fuel oil per horsepower hour, the actual consumption was .4576 pound, or less than one-half pint of fuel oil. With oil at 3 cents (0/1½) a gallon, the fuel cost per hour was only 9⅜ cents (0/4 3/16). The dimensions of the boat are: Length, 54 feet; beam, 12 feet 4 inches; depth, 6 feet 2 inches; draft, forward, 2 feet 9 inches; aft, 4 feet 2 inches; displacement, 40,500 pounds. The propeller is 38 inches diameter and 38-inch pitch, with a developed area of 456 square inches.

Mietz & Weiss Oil Engine Installations on Commercial Boats

In many types of commercial boats Mietz & Weiss marine oil engines, operating on common kerosene (paraffin), fuel oil or crude oil of suitable quality, are installed with very satisfactory results. No gasolene (petrol) is used in engines of this type, and they are, furthermore, free from such complications as electric ignition devices, carbureters, vaporizers, cams, gears, valves, cam shafts and the like, which, added to the low operating cost, safety, simplicity and reliability of operation, make the engine a most desirable class of power for a work boat proposition. These engines are furnished by August Mietz, 128 Mott street, New York, in three-cylinder units and over. They require no reversing clutch, the engines themselves being started and reversed in the same manner as an ordinary steam engine, using, however, compressed air from an air storage tank, which in turn is supplied by a small air compressor attached to and operated by the engine. For large units a separate air compressor unit is furnished so that the air can be compressed independently of the engine.

A feature of the Mietz & Weiss engine is the S. & W. distributor, which is a rotary valve with positive drive from the main shaft of the engine, controlling the flow of air from the air pressure tanks to the cylinders in proper order for rotation in either direction at the will of the operator at the controlling lever in front of the engine. A feature of primary importance in the reversing of oil fuel engines is the control of the oil injections; that

is, the oil injections must cease positively as soon as the controlling lever is moved to reverse the engine, allowing compressed air to enter the cylinders in counteraction to its normal rotation. It is claimed that the S. & W. distributors solve this problem by a very simple mechanism of positive movements. The controlling lever moves over a dial which is lettered "ahead," "astern" and "stop." The compressed air is shut off on the "stop" mark or flows to the engine for a direction of rotation, according to the dial indication. The movement of the lever also positively controls the oil to the engine, or to a by-pass, in such a manner that the oil is cut out first. The engine can then receive no oil unless it again starts to run in whatever direction desired, and to the position of the controlling lever. In the "stop" position of the lever, the air pressure is shut off and the oil cut-out is positively locked.

Some typical installations of the Mietz & Weiss oil engines on work boats are shown in the following illustrations. Fig. 1 shows one of the harbor police boats, two of which are in operation in New York harbor equipped with Mietz & Weiss 15 horsepower double cylinder engines. Fig. 2 is a view of the ferry *Miss Vandenberg*, owned by the Ogdensburg & Prescott Transportation Company, Ogdensburg, N. Y., and plying between Ogdensburg and Prescott, Ontario. This ferry is equipped with two 75-horsepower Mietz & Weiss three-cylinder units and has been in operation since 1910. Fig. 3 is a sternwheeler used by the Canadian Government for survey purposes in the Saskatchewan district. This boat is equipped with a Mietz & Weiss 15-horsepower double cylinder oil engine. Two 50-horsepower Mietz & Weiss double-cylinder oil engines are installed in the tugboat *Robert* shown in Fig. 4, used by the Atlantic Freight & Steamship Company in tropical regions for towing fruit scows. At the present time the Mietz firm is building for the Lighthouse Service of the United States Government a 100-horsepower Mietz & Weiss direct reversible engine for lightship No. 98 for use on the Great Lakes, and also a 150-horsepower three-cylinder reversible engine for lightship No. 54, for use on the New England coast.

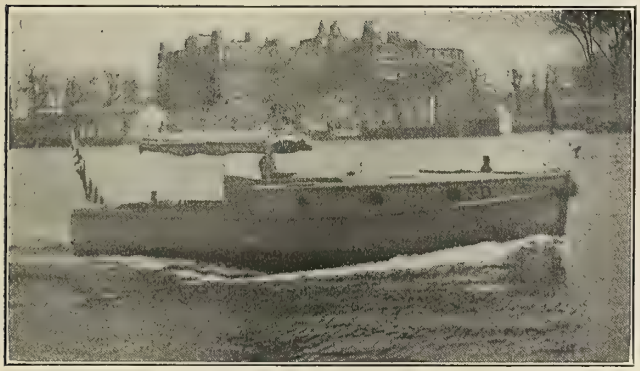


Fig. 1.—Harbor Police Boat

Fig. 2.—Motor Ferry Boat

Fig. 3.—Canadian Government Survey Boat

Fig. 4.—Tugboat *Robert*

Car Ferry Henry M. Flagler

A new car ferry for the Florida East Coast Railway System is now nearing completion at the yards of the William Cramp & Sons' Ship & Engine Building Company, Philadelphia, Pa. The vessel was designed by M. C. Furstenau, naval architect, Philadelphia, and will transfer cars between Key West, Fla., and Havana, Cuba, a distance of about 100 miles. The hull is 360 feet long over all, 57 feet beam molded, 22 feet depth molded, with a deadweight carrying capacity of 2,500 tons at a draft of 15 feet. Four sets of tracks are arranged on the main deck, giving accommodations for thirty of the largest size refrigerator cars. The designed speed of the vessel loaded is 13 knots, and it is expected that the run of 100 miles from dock to dock will be made in eight hours.

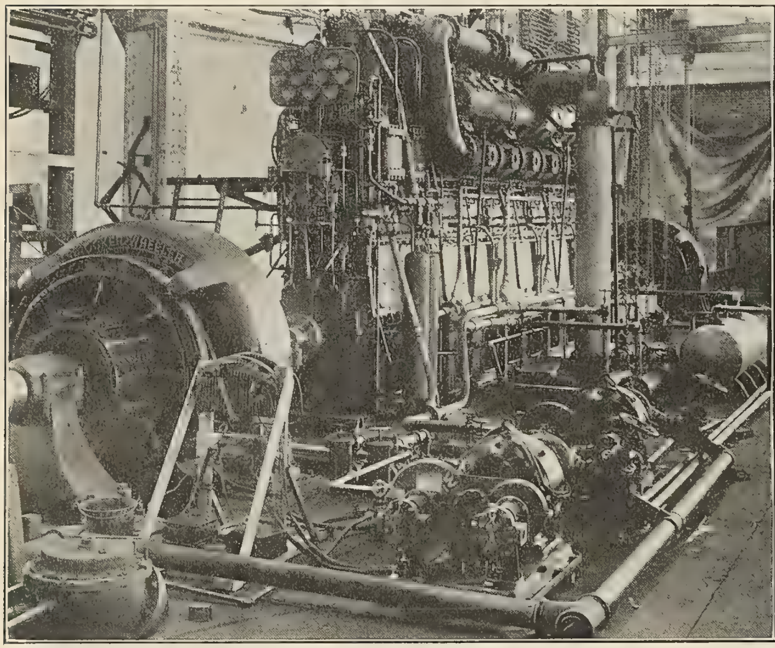
The power plant consists of two triple expansion engines having cylinders 20 inches, 32½ inches and 54 inches diameter by 36 inches stroke. Each engine is designed to develop 1,500 indicated horsepower. Steam is supplied by four Scotch boilers, each 13 feet 2 inches diameter and 12 feet long, fitted with two 48-inch Morison corrugated furnaces and designed to operate under the Howden system of forced draft at a working steam pressure of 170 pounds per square inch. Coal will be used for fuel.

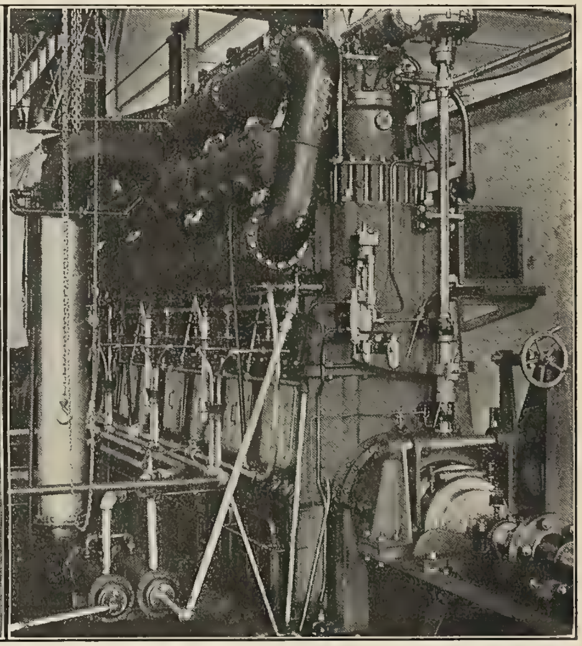
The usual auxiliaries are fitted in the engine room, the only notable difference being the fitting of two 12-inch centrifugal pumps by which the ballast tanks can be filled or emptied in a short space of time. The ballast tanks

have a sufficient capacity to load the vessel to her normal draft in case no cargo is carried.

In addition to the arrangement for carrying cars, the vessel is fitted with three cargo holds having a capacity for storing approximately 300 tons of cargo. Each hold is served by a double drum electric cargo hoist. In addition to the dry cargo, one of the forward ballast tanks has been arranged for carrying molasses, the necessary filling and discharging apparatus being fitted.

The keel of the vessel was laid at the Cramp shipyard April 20, 1914, and all of the machinery was completed and the vessel launched on September 22. It is expected that the vessel will be placed in commission during the early part of December. Both the hull and machinery have been built to the highest classification of Bureau Veritas under the supervision of the designer of the vessel.





Two Views of 1,000 Horsepower Nlseco Marine Diesel Engine Undergoing Shop Test

Shop Test of 1,000 Horsepower Marine Diesel Engine

There has recently been completed at the works of the New London Ship & Engine Company, at Groton, Conn., a 1,000-horsepower marine Diesel motor of the Nlseco type. This engine, which is the largest marine engine of its kind constructed in the United States, has recently completed its shop trials, and we are able to give some of the results obtained.

The engine was placed on the test stand and connected through shafting to two 600-kilowatt generators, one of which was placed at the forward end and one at the after end of the engine. Two generators were used, as there was no single generator available of sufficient size to supply the necessary load. The current from the generators was absorbed by water-cooled rheostats.

The pumps for circulating water, lubricating oil and piston cooling water were assembled on a common bedplate and driven by electric motors. These pump sets were in duplicate, but only one set was used for the engine at full power, the other being an auxiliary set used as a standby in case of breakdown of the first. The arrangement of pumps was not identical with the arrangement on shipboard, but the pipe connections and arrangements of piping were laid out to duplicate as nearly as possible the conditions which will obtain when the engine is installed. The current for driving the motors was taken from the generators driven by the engine.

The fuel oil supply tank was placed at a high level in order to feed to the fuel pumps by gravity, this being the arrangement on shipboard where a gravity tank is installed.

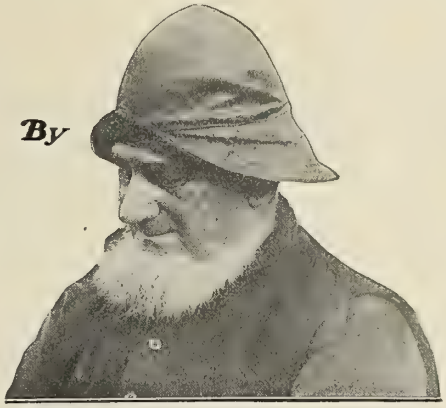
The current from the generators was carried through ammeters and voltmeters upon a switchboard before passing through the rheostats, in order that readings might be taken to determine the horsepower generated. Thermometers were installed at different points on the engine to determine the temperature of the circulating water at the inlet and outlet, the temperature of the scavenger receiver and the temperature of the lubricating oil at the inlet and outlet.

A number of different test runs were made, the longest being one of 48 hours, which was made at approximately 900 horsepower. Shorter runs were made at varying powers from 200 to 1,100 horsepower. Although the engine is rated at 1,000 horsepower, at 1,100 horsepower there was evidently considerable reserve power without excessive fuel consumption or without excessive smoke in the exhaust. The general results of the tests were very satisfactory, especially in consideration of the fact that this was the first engine of its size to be built in this country.

On the 48-hour test the following results were obtained:

Average brake horsepower	906.37
Average fuel consumption, pounds per hour	467.68
Average fuel consumption, pounds per horsepower-hour	.515
Total fuel consumed, pounds	22,448
Total fuel consumed, gallons	3,161.6
Total lubricating oil consumed, gallons	125
Total fresh water consumed, gallons	132

Economy Talks By "Old Scotch"



The American Merchant Marine

Brother engineers, I'm going to take for my text to-day "The American Merchant Marine," as I do not know of any subject that is of more economic importance to this country just now than to have enough ships flying our flag to carry our products, and, incidentally, to give employment to all of us. I am one of the few living American engineers who can remember when we had "right smart" (as they say down South) ships of our own in the foreign trade. "Right smart" applies to quality as well as to numbers, as we certainly had some corking good ships that could outsail anything afloat. But, alas and alack! that noble old fleet has gradually disappeared from the ocean. I'm not so much interested just now as to how they disappeared as I am in how to get another fleet.

We really need our own ships in the foreign trade more now than we did when we had one of the best fleets in the world. That may sound strange, but fifty or sixty years ago, when we had ships, we were practically a nation of farmers, and exported, principally, the products of the soil, which foreign buyers were bound to have, anyhow, as they needed our stuff to live on; nowadays we still export some foodstuffs and raw materials, but are gradually getting to depend on manufactured articles for our export trade, and that's how we are going up against some pretty hard competition, as other nations are "some pumpkins" at manufacturing the same stuff that we do. In fact, all the great nations of the earth might be compared to rival business houses trying to sell their goods to the other nations which are not so great, and to each other, of course. I'm sorry to say that just now several of our larger friends in Europe have suspended business and gone to fighting for a living.

Anyhow, in this battle for trade it looks as if we ought to conduct ourselves like a good business house, and as any first-class business establishment has to have its own delivery wagons, if it wants to stay in business long, it looks to me as if this good old U. S. A. of ours was rather overlooking its hand by trying to deliver about all of its goods in the other fellows' ships, which, after all is said and done, are nothing but the delivery wagons of the sea. Wouldn't you give the laugh to an oil drummer who tried to sell you enough lubricating oil for a voyage and said he would have to deliver it to you in one of his rival's wagons, as his firm didn't believe in hiring drivers and supporting horses?

Of course, there isn't a bit of doubt but what foreigners can run ships cheaper than we can, and that is due principally to the fact that we fellows who run the ships here get more pay and are better fed than the people on foreign ships. I don't hear any of you remarking that you would like to work for any less than you do now, or that you would put up with poorer grub. Now, as long as we have got to have our own ships for the foreign trade in order to get our share of the world's business, and none of us who run the ships is going to accept any less than he gets now, if he can help it, what's the answer?

I'll tell you what it is! The Government has got to help out. And why shouldn't it? Do you know that every dog-gone business of any kind in this country is protected except our merchant marine in the foreign trade? That isn't possible, you say. Well, just think it over and you will conclude that I'm right. Every industry is protected either by the tariff, the climate or the great oceans on both sides of us. The Atlantic and Pacific are more consistent protectors than the tariff, as they never vary. No matter what you manufacture in this country, you're bound to have from three to four thousand miles cost of freight in your favor before any foreign goods can be brought here to compete with you. Not so with our registered merchant marine, as that has to get out and hustle in open competition with the ships of all other nations; and worse than open competition, they have to go up against rivals who are subsidized by their governments, in the bargain. This subsidy business doesn't seem to appeal to our law makers, but you can bet it's the surest way to keep your ships going. I felt the same way about tips when I boarded in a restaurant. I just got my back up and allowed as how I would be gol-darned if I was going to resort to any such un-American, undemocratic and outlandish foreign practice as giving tips to waiters who were already drawing pay for their services. I kept my back up for about six months, and I was always the last one waited on; my potatoes were always cold; the only parts of the chicken I got were the neck and wings, and on Fridays I varied between the gills and the tail of the fish. I got so thin by that time that after a final cursing of the fiendish system I began digging up a tip every once in a while, like all the rest of the fellows at the table. You can see that I haven't been very thin since then.

The foreign shipping department of the U. S. A. has been living on necks, wings and gills for a long while. As a result of losing over two hundred and fifty millions of dollars every year to foreign delivery wagons your Uncle Sam is getting rather thin in his exchange department. If he wants to fatten up his finances a bit he'd better be giving out a tip now and then to encourage his own merchant marine. If he doesn't like to swallow the subsidy system outright, as all his rivals are doing, let him ease off his conscience and enroll all of us ship drivers in his Naval Reserve and give us enough pay out of his vaults to make up the difference between the pay rates on foreign vessels and the American standard of wages, which gives us a decent living. In this way ship owners could afford to put vessels in our foreign trade and our dear old Uncle, by going down in his jeans annually for only four or five million dollars, would keep at least half of that two hundred and fifty million delivery-wagon money at home.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

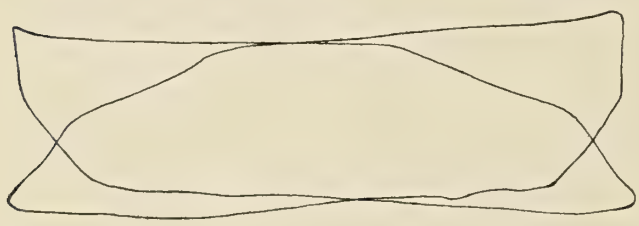
Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT*

This department is maintained for the service of marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—I have been running on one of the regular steamers between Boston and Savannah, and have had more or less trouble with the high-pressure engine. The inclosed card is taken from the high-pressure cylinder of the engine, which is a triple expansion engine, and I should be glad if you would explain what defects the card shows, the causes of same, and how they may be remedied? L. L.

A.—There is insufficient information as to what sort of trouble is encountered to permit of any definite answer. The card is not seriously defective in any particular and



Indicator Cards from High-Pressure Cylinder of Triple Expansion Engine

the only undesirable feature shown is the rise in the back-pressure line of the left-hand card (probably the bottom card, though the question gives no information) which indicates restricted exhaust. This might be due to too much exhaust lap, or improper valve setting. It is probable that the troubles experienced arise from improper mechanical adjustment or alinement.

Q.—Does it cause any weakening of iron pipe, or any article made of iron or steel, by having it galvanized? No. 30.

A.—If properly done, galvanizing does not cause any reduction in strength in articles commonly so treated. In very thin piping or sheets the acid treatment previous to the zinc bath may cause sufficient reduction in the original metal to affect the strength. If two articles, one galvanized and the other not, are to be compared for strength, care should be taken to use the dimension under the galvanizing for proper comparisons, as zinc has much less strength than steel.

Q.—Please inform me regarding the conditions which determine the sequence of cranks in a four-crank vertical marine engine. Also the approved method of ascertaining this sequence in an engine of the type mentioned by simple inspection; that is, without disconnecting any parts. W. S.

A.—The sequence of cranks has an appreciable effect upon the resultant rotative effect diagram of any multiple crank engine, and a proper balancing of the engine must take this into account. This comes from the fact that the order in which the different cylinders below the high pressure take steam from their respective receivers materially affects the character of the steam forces in these cylinders, and this is shown in the indicator diagrams. To determine what the sequence is in any engine stand aft of the engine and record each crank as it passes the upper dead point when turning over in the go-ahead direction.

Q.—I have always been under the impression that when the steam space was doubled the steam pressure was halved. Some ten years ago I was chief engineer of a twin-screw steamer of about 2,500 indicated horsepower. We had two double-ended steam boilers. We laid up our steamer for the winter months. When we were getting ready for the summer's work, I found the safety valves on the starboard boiler leaking badly, so I drew the fires out of both boilers, blew off the steam on the starboard boiler and overhauled the safety valves. After having the valves, as I thought, put to rights, in order to save further delay I opened up the stop valves of both boilers. At that time the port boiler had a pressure of 100 pounds, and I supposed that by connecting to the starboard boiler the steam pressure would drop to 50 pounds, but, instead of that, it dropped only to 90 pounds. I would like to have an explanation of this. P.

A.—The law stating that the volume is inversely proportional to the pressure holds only for a perfect gas and assumes a *constant quantity* of gas is dealt with (as one pound). The reason the pressure did not drop lower (assuming the boilers were filled to the same level) was that the boiler at 100 pounds immediately began to make steam when the pressure, and therefore the temperature of the steam in it, was reduced by letting the steam over into the other boiler. Then the water was still at about 338 deg. F. and the steam at a much lower temperature, so that water vaporized into steam and the pressure rose till equilibrium was restored. Of course, if the water level in the overhauled boiler was higher than that in the other, it would augment this rise. If you could have isolated the steam in the 100-pound boiler and let it expand into a space equal to twice the steam space of the boiler the resultant pressure would have been very nearly 50 pounds.

Q.—What is meant by corresponding speeds of experimental models and full-sized vessels? Exp.

A.—If one imagines a small vessel to grow in size, all linear dimensions would expand in the same proportion, and the resultant large ship would be geometrically similar to the original. The speed would also grow, but in the proportion of the square root of a linear dimension. This comes from the fact that the resistance is assumed to be proportional to the displacement and the density of the water remains constant as follows: $R \propto D$. D = displacement; R = resistance; but displacement being a volume varies as the cube of a linear dimension so that $R \propto l^3$.

The resistance is a force and so is proportional to $\dfrac{mv^2}{l}$, where m and v are mass and velocity respectively, then

$$l^3 \propto \frac{mv^2}{l} = ll^3 \propto mv^2$$

and as the density of the water does not change

$m \propto l^3$, substituting we have $v \propto \sqrt{l}$.

So that if two similar ships have lengths of l and l', the speeds proportional to the square roots of their lengths are called corresponding speeds. If 25 feet and 400 feet were lengths, respectively of model and ship, the model being driven at 5 knots speed would correspond to a speed of 20 knots for the large ship.

$$\frac{5}{V \text{ of ship}} = \sqrt{\frac{25}{400}}, \text{ therefore } V \text{ of ship} = 5 \times 4 = 20 \text{ knots.}$$

* Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

Q.—What is the relation between propeller thrust in a ship and towing force of a model at corresponding speeds? H. S.

A.—The relation between the resistance of a ship and the resistance of a model at speeds proportional to the square roots of the lengths is given approximately as proportional to the displacements. Strictly, this applies only to the wave-making resistance, as the frictional resistance does not follow the law of comparison, but for first approximation it is sometimes applied to the total resistance. To predict the resistance accurately it is necessary to separate the model resistance into its frictional and wave-making components, expand the wave-making as above, and figure the frictional for the large vessel, taking account of the reduced coefficient of friction for the larger ship and add together. This gives total resistance, which, however, is not exactly the propeller thrust, as that is slightly augmented by the wake.

Q.—Please give formulæ for horsepower required in estimates of thrust and speed for screw and paddle-wheel propulsion. H. F. B.

A.—A formula based upon the theory of mechanical similitude for the effective horsepower of ships is as follows:

$$E.\ H.\ P. = .000307 \left(f\ S\ V^{2.83} + \frac{b\ D^{2/3}\ V^5}{L} \right)$$

where the individual letters have the following significance: *f*, coefficient of friction of water on the wetted surface; *S*, wetted surface of the ship; *V*, speed in knots; *b*, factor for wave-making resistance; *D*, displacement in tons, and *L*, length on the waterline.

For well-formed ships of moderate speeds the coefficients *f* and *b* may be given the values of .01 and .5, respectively. This gives the *effective horsepower,* which is the *net power* used to drive the vessel. This should be increased by the losses in the engine and propeller in order to get the indicated horsepower. If we assume an engine efficiency of .85 and a propeller efficiency of .65, the resultant efficiency of propulsion becomes .55 and the formula for indicated horsepower may then be written

$$I.\ H.\ P. = .0056 \left(.01\ \ S\ V^{2.83} + \frac{.5\ D^{2/3}\ V^5}{L} \right)$$

If the efficiency for propulsion in case of the paddlewheel is different from the .65 assumed for the propeller, that will affect the formula in the same proportion. This formula is useful when data from other vessels similar to the one to be designed are lacking. If vessels similar to the one to be designed are available the admiralty coefficient formula should be used of I. H. P. $= \dfrac{D^{2/3}V^3}{K}$, K being derived from the prototype, for which data are available.

Q. Please explain how the gross tonnage of a ship is computed. T. A.

A.—There are three tonnages customarily referred to as registered tonnages—gross, net and underdeck. The one first derived is the *underdeck tonnage,* which is defined as volumetric contents of the entire vessel below the tonnage deck. The tonnage deck is the upper deck in ordinary full scantling vessels and the deck below the shelter or awning in shelter or awning deck vessels. This tonnage is simply the volumetric capacity of the entire interior of the vessel below the bottom of the beams of the tonnage deck, and taken to the inside of the sheathing and over the top of the double bottom. In practice it is determined by taking the areas of a number of transverse sections, in accordance with the rules of the Department of Commerce and Labor, and summing them by Simpson's rule for volume. To the underdeck tonnage should be added all spaces which come under the heading of permanently covered and closed in spaces on the upper deck. This gives the *gross tonnage. Net tonnage* (from an economic point of view the most important, as it is almost universally accepted as the legal basis for levying port charges, pilot dues, etc.,) is obtained from the gross tonnage by subtracting the spaces set apart for propelling power, crew spaces, master's accommodation, chart room, boatswain's stores, donkey engine space, etc.

Q.—Please explain the comparative merits and demerits of steam, electric and hydraulic cargo gears on board ship. What is the reason that electrical cargo gear is used to such a limited extent on American steamers? C. C.

A.—It is difficult to give a reasonable comparison of the merits and demerits of the different gears mentioned, as the installation of electrical, and, especially, hydraulic cargo-handling gears are few. In brief, the comparison may be listed as follows:

	Steam.	Electric.	Hydraulic.
First cost	Cheapest.	High.	High.
Speed of discharged cargo	Fast.	Fastest.	Slow. Most suitable for heavy work.
Maintenance lost	Slight.	Moderate.	May be high.
Local consumption	High.	Best.	High but better than steam.
Weight	Heavy.	Heavier.	Heaviest.
Noise and vibration	Great.	Less.	Least.

The repairs to the steam can usually be looked after by the regular engineer's force, and the system is usually operated from the donkey boiler in port. The electric may be operated from a shore plant. Hydraulic cannot be used where low temperatures are found, as it will freeze up.

Q.—As an estimate for a ship is often required in a hurry, will you kindly give some satisfactory method of obtaining the steel weight rapidly, say, for the hull, excluding superstructure and deck-houses of a ship, for which there is no basis to work from? Also what percent difference is there in this weight between Lloyd's, Bureau Veritas and British Corporation Rules? A. O. T.

A.—The difference in finished steel weights for the same ship built to Lloyd's, Bureau Veritas and British Corporation Rules is very low, much less than the accuracy of any formula which can be used for estimating hull steel weight. The methods of determining approximately the hull weights for estimating purposes may be divided into two classes; one, the cubic number method, and the other the surface foot method. In the cubic number method, so-called, the weight of hull is taken as the percentage of the product of the length, breadth and depth, the percentage varying with the type of the proposed ship. This method assumes that the hull weight is a function of the ship's volume, and while this is partially true, it is more nearly proportional to the superficial area of structural work than to the volume enclosed. The ratio of superficial area to volume is not constant, but is dependent upon the proportions of length, breadth and depth, so that there are considerable variations in the coefficient used in the cubic number method even for vessels of the same general type. This coefficient ranges from .36 to .43, and the formula should be used with considerable discretion. The larger coefficients are found with the vessels having the largest ratio of length to depth and breadth to depth. The surface foot method assumes that the ship's weight is a function of the area of the sides and bottom of a trough whose width is equal to the breadth of the hull and whose depth is the depth of the hull; thus:

$$\text{Surface foot} = L \times (B + 2d).$$

As the weight of structural work of a given hull is proportional to its gross surface, this method usually gives

somewhat more accurate results than one depending upon enclosed volume, and for ships whose interior arrangement of bulkheads and decks is similar, gives reasonable satisfaction. The pounds per surface foot usually range from 97 to 125. From the above it is obvious that the steel hull weight of any new design cannot be determined with accuracy, unless the vessel is similar to some existing construction of which the weights are known, but these may serve as a help in getting out approximate estimates of weights for moderate-sized passenger and freight vessels.

Q.—I have a 12-inch by 18-inch double engine, cut-off .7 of the stroke, 85 pounds boiler pressure, non-condensing, 80 revolutions per minute. About what horsepower would it indicate? I intend to convert the above engine into a compound condensing engine; what size should the high-pressure and low-pressure cylinders be to indicate the same power? What percentage saving in coal consumption should I expect? What is the best method of propulsion for towing, the screw propeller or the paddle wheel? C. P.

A.—The single-cylinder engine will have about 90 indicated horsepower at 80 revolutions per minute. A compound condensing engine to develop this indicated horsepower may be $12\frac{1}{2}$ inches by $28\frac{1}{4}$ inches by 15 inches stroke. Assuming cut-off in the high pressure at .6 stroke and cylinder ratio of $\frac{1}{2.5}$ and revolutions per minute = 80.

Business for the Big Schooners

The Coastwise Transportation Company, of Boston, Mass., which operates five steel 5,000-ton steamers and four large schooners in the Atlantic coast coal trade, recently inaugurated a new system for the prompt delivery of its commodity when the steamer *Middlesex* sailed from Norfolk with the four-mast schooner *Henry W. Cramp* in tow, both bound for Boston with cargoes. The expedient suggests more extensive adoption as a means of temporary employment for the many big schooners which have been lying idle in recent months; as for instance the four-, five- and six-masters of the Winslow Company, of Portland, Maine, seventeen of which were laid up several months last summer for want of charters.

It is pointed out that the big fore-and-afters could emulate the genus barge to the extent of going to sea with skeleton crews, astern of steam colliers or tugs; earn at least small dividends for their owners, and stand ready to re-enter business under their own sail at such time as a demand for both steam and sail tonnage reasserted itself, as it undoubtedly will after the present depression in the freight market.

This method of transportation has been successfully tried out in other trades. The ill-fated *Thomas W. Lawson,* the only seven-mast schooner ever built, had been fitted with tanks and towed in the oil trade under long-time charter from her owners, the Coastwise Transportation Company, though she was under her own sail when wrecked on the Scilly Isles, December 13, 1907, on a passage from Philadelphia to London.

The steel five-master *Kineo,* lately sold by Arthur Sewall, of Bath, to Baltimore owners, likewise was used as a tank barge in the Gulf oil trade, but at present is making regular voyages under canvas. The wooden five-master *Harwood Palmer,* now running between Hampton Roads and Portland in the coal trade, was chartered by the Union Sulphur Company a few years ago and brought several cargoes of the crude product from Texas to New England ports in tow.

Indeed, an argument against dismantling the big schooners and permanently converting them to barges is seen in a recent performance of the steel-tank, six-master *Delaware Sun,* owned by the Sun Oil Company, of Philadelphia, which, though shorn of her topmasts and officially rated as a barge, still retains much of the sail spread that she had when she was the collier *William L. Douglass* and owned by the Coastwise Transportation Company.

The *Delaware Sun* was bound from Philadelphia to London with a cargo of oil in tow of the tank steamer *Yosemite* when she broke adrift in a heavy gale in mid-ocean. The steamer, harder hit than her consort, sought shelter without trying to pick her up again. The *Delaware Sun* accordingly made sail and went into the Thames on her own hook. Meanwhile the *Yosemite,* an ancient craft, had been towed to the Tyne and condemned. So the *Delaware Sun,* left to her own resources again, discharged her cargo and sailed back to Sabine Pass, Texas, although under her short sail it took her fifty-seven days to make the passage.

On the Lakes the many large schooners which were unlucky enough to be serviceable when steam craft usurped the last vestige of their business were permanently dismantled at a sacrifice, and without exception are ending their days as barges. But on the Pacific coast the Union Oil Company, of Los Angeles, and the Associated Transportation Company, of San Francisco, are going both the Atlantic and the Great Lakes one better.

Their fleets of tankers include the four-mast steel ship *Erskine M. Phelps,* late of Bath, and the Glasgow-built ships, *Falls of Clyde* and *Marion Chilcott.* These staunch craft are permitted to keep their yards aloft as in their palmy, wind-jamming days, and make voyages either under sail or in tow as the exigencies of the trade require.

Lloyd's Quarterly Shipbuilding Returns for the United Kingdom.—At the close of the quarter ended September 30, Lloyd's Register of Shipping reports 486 merchant vessels of 1,723,550 gross tons under construction in the United Kingdom. Although the tonnage now under construction is about 1,400 tons more than that which was in hand at the end of the last quarter, the rate of progress in merchant ship construction is much reduced on account of the war, and the immediate output will be correspondingly less than would be attained under normal conditions. The war also makes it impossible for Lloyd's to publish for the present the usual information regarding the shipbuilding industry throughout the world.

Shipbuilding Returns in the United States.—According to reports from the Bureau of Navigation 283 vessels of 56,510 gross tons were built in the United States and officially numbered during the three months ended September 30. As compared with the tonnage built in the corresponding quarter last year, this shows a decrease of 37 percent. During the month of September 83 vessels of 17,184 gross tons were built and officially numbered, the largest being the *Medina,* of 5,426 gross tons, built by the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., for the Mallory Steamship Company, New York.

Launch of Large Western River Excursion Steamer.—On October 17, the hull of a large steel river excursion steamer was launched at the yards of James Rees & Sons Company, Pittsburg, Pa. The boat is 160 feet long, 40 feet beam, with 3-foot guards, making a total width of 46 feet. The depth of the hold is $4\frac{1}{2}$ feet. The vessel is built of steel throughout, and is divided into forty-one watertight compartments. She will be used in southern waters, principally in the vicinity of Memphis, Tenn.

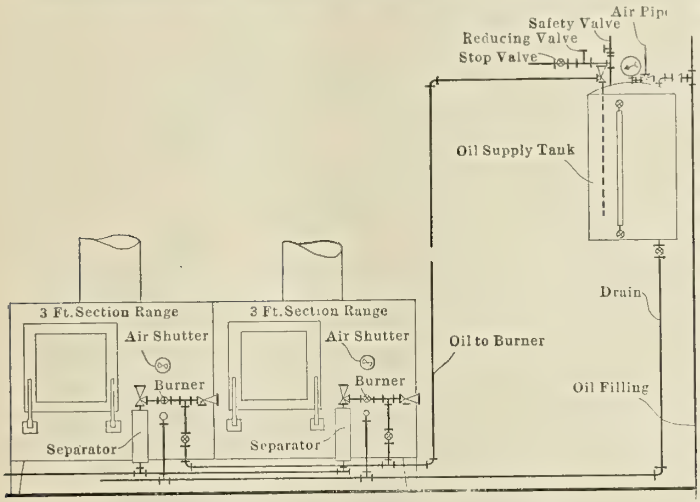
Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Oil-Burning Galley Ranges

The results obtained with a fuel oil-burning range fitted recently in the galleys of a number of the United States torpedo boat destroyers were so satisfactory that this type of range is now being installed on all destroyers which burn oil fuel. The installation consists in modifying the firebox of the Standard range by removing the parts required for coal and fitting firebrick of a special design. A burner having a 1/32-inch opening was developed after numerous trials. Steam is used to create the pressure on the oil, and, as it both heats and thins down the oil, there is no trouble regarding the flow. Steam is also used at the burner, being first passed through a separator designed for this installation. The accompanying sketch shows the principal features of the installation as fitted.



Arrangement of Galley Range for Burning Oil

A. H. NOURSE.

Navy Yard, Brooklyn, N. Y.

Repairs to a Piston-Rod Gland

The engineer of a tug on the Hudson River recently allowed his fireman to pack a piston-rod gland. In attempting to blow out the old packing with steam, the fireman broke the gland on each side of the rod, so that it was in three pieces. It was impossible to have a new gland cast at the time, so the difficulty was overcome by using a piece of half-inch boiler plate to hold the three pieces together.

The engineer released the piston rod from the crosshead and held it up by attaching a lathe dog to the tail-rod. The piece of the gland on the piston rod was removed and the three pieces clamped together with the piece of boiler plate on the bottom. Holes were then drilled through the boiler plate for the piston rod and studs and through the gland and boiler plate for bolts. There were four holes for bolts, two in the center piece and one in each of the other pieces. These were threaded and countersunk on the boiler plate side. Bolts were then screwed into these holes, cut off about flush on the countersunk side and riveted over to fill the countersink. This was done because of the small clearance. The edges of the plate were ground to the form of the gland, in order to make a neat job, and the gland replaced. G. T. C.

Propeller Corrosion

Propellers, like all other parts of a vessel's hull or machinery, are liable to corrode. This corrosion on propellers is found in the form of pitting on the backs of the blades at the tips. This often goes right through the blades, and in some cases the tips are so weakened that they are thrown off or are wasted away. The corrosion is most severe in cast iron blades, but cast steel is not far behind. Bronze composition blades are the only ones that are comparatively free from this fault.

The causes of this corrosion are many, but the foremost one seems to be due to the propeller backs and tips being exposed to the action of a mixture of air and water. Air causes the pitting in boilers, and in a like manner causes it on propeller blades. The air is drawn down from the surface when the propeller is not wholly submerged, and even when the tips approach closely to the surface the eddies formed are strong enough to draw down the air. This happens when the vessel is not fully loaded or when she is in the ballast condition. The blade tips are also exposed to this action when the vessel is pitching in a seaway and the blades are partly thrown out of the water. This corrosive action goes on at a very much slower rate when the wheel is stationary, and I believe that this is a proof that the air in the eddies back of the blades is the chief factor in causing this excessive pitting.

That this corroded condition of propeller blades is common is seen upon a visit to some of the large repair yards where boats are docked for painting and repairs. It has often been a surprise to the writer to see how far this corrosion is allowed to go on a great many vessels before the blades are changed. Upon inquiry it has been ascertained that some chief engineers consider it very good economy to run upon these blades until the extent of the corrosion is so great as to break the blades, or until the speed of the vessel is materially impaired. This has always seemed such a poor policy that the writer, by means of data available, has gone into the subject, and, while it is almost impossible to reduce the effects of corrosion to actual figures. results have been obtained that are true in a comparative sense, and at the same time check well with theory. In this short paper only results will be given in a general way because the figures would vary to so great a degree that the values in one case would not be applicable to any other case.

As mentioned before, the pitting goes right through the tips of the blades, and so, of course, reduces the area of each blade. In some cases this reduction is considerable. The loss in area means a greater effective thrust per square inch of projected area if the same power is to be transmitted by the blades. To maintain the same speed the effective horsepower must be the same, or, in other

words, we must have the same total effective thrust. This increase of thrust per square inch of projected area would increase the slip, which in most cases would be accompanied by a drop in the propulsive coefficient, and these two would cause the vessel to slow up unless the revolutions were increased. The loss of area would tend to increase the revolutions, but this could never take place, because the surface friction of the corroded tips is very great. What actually does happen is that the revolutions are decreased by this resistance to turning, and this results in a decrease in the vessel's speed, since speed equals revolutions $\times$ pitch $\times$ (1 — slip). The drop in the revolutions may tend to decrease the slip, but the increase due to loss of area would more than compensate this favorable slip.

Summing up, we find that corrosion of propeller-blade tips has the effect of decreasing the speed of the vessel through lessening the area of the blades, decreasing the revolutions per minute, increasing the slip and causing the propulsive coefficient to drop.

In some cases the corrosion is so severe as to eat away almost entirely the tips of the blades so that the diameter is slightly reduced. The effects of this are different from those due to the loss of area, but the results are almost the same. If the same power is to be transmitted by a propeller of slightly smaller diameter, assuming the area ratio about the same, the revolutions will have to be increased. This would mean an increase in the slip and a decrease probably in the propulsive coefficient, and, with the same power, a slight decrease in speed, due to the latter. However, as before, the revolutions cannot be increased, due not only to the high surface friction of the pitted blades, but also due to the greater thickness and breadth of the tips at the tip section; the real tips being corroded away. This means that the revolutions will be decreased, and therefore the speed of the vessel reduced, beyond the reduction due to the increased slip and decreased propeller efficiency mentioned above. In the case of the broken-off or corroded-away tip the reduction in speed is naturally greater than that when only the area was reduced, due to the pitting. This is consistent, because the slighter the corrosion the slighter the effect.

As mentioned before, cast iron blades offer the poorest resistance to corrosion, and it has been recommended time and time again that their use be discontinued except for special purposes. Steel is little better than cast iron, but its greater strength allows it to be made less heavy, and therefore more efficient. Bronze or compositions are the only logical materials for propeller blades. These metals may be cast with very smooth surfaces and sharper edges with less tip thickness, because of their strength, and also because no extra thickness has to be added to allow for the wasting away due to corrosion. Zinc plates, however, must be placed upon the vessel's hull to prevent galvanic action.

All the above-mentioned points add to the propeller efficiency, and this, coupled with less weight, means a saving in running costs.

Detachable blades are, of course, preferred for merchant work, and this means a bigger loss than when solid propellers are used. However, since the function of a boss is to form a means of attachment for the blades, it needs only be large enough to do this in an efficient manner, and why such large and heavy bosses are fitted in so many cases is hard to understand. The writer knows of cases where otherwise good propellers have been spoiled by their large and heavy bosses. A large boss is hard to turn and causes great eddy resistance, thereby causing the blades to work in disturbed water, which causes vibration. The extra weight puts the tail shaft under a greater stress than necessary.

The only argument one has against bronze blades and good propellers is first cost, but let engineers look into the upkeep and running cost necessary to maintain maximum efficiency and the writer believes more old propellers will find their way to the scrap heap.

Brooklyn, N. Y. F. K. Ruprecht.

Repairs to Air Compressor Cylinder of Refrigerating Ship

The cold storage plant of a refrigerating ship is of the greatest importance to the ship, more important even than the propelling machinery, for the shutting down of the propelling machinery for repairs, while perhaps an annoyance, does not involve any risk to the cargo as long as the refrigerating plant continues to be in good condition. When, however, occasion arises to make repairs at sea to the refrigerating plant of a ship carrying fresh or frozen meats, the urgency for quick action is borne in on everyone concerned. The plant must be placed in operation as quickly as possible.

On a ship of 8,000 tons and 1,800 horsepower a cargo of 600 tons of frozen meats, besides quantities of butter and eggs, was carried. The meat holds were kept at temperatures of from 15 to 18 degrees F., while the butter and eggs were carried in compartments where the temperature was kept at 30 degrees F. It was necessary to keep the butter and egg compartments constantly as nearly at this temperature as possible, not varying more than a degree or two if the best results were to be obtained.

The ship operated in tropical waters, where the heat of the sun on the decks and sides of the ship, and the high temperature of the sea water, caused a rapid rise of the temperature in the cold rooms if the refrigerating machinery was shut down for any length of time. Even while running, great care was necessary to distribute the cold air in the various compartments in order to maintain them at their proper temperatures.

The refrigerating machinery consisted of two Hall & Haslem machines of the horizontal steeple compound type, which compressed the air to 60 pounds pressure, and after expanding it down to atmospheric pressure, exhausted it into trunks, or ducts, that conveyed it to the cold rooms, where it was discharged directly into the compartments on one side of the ship, the return air being drawn back to the machine through similar trunks on the opposite side of the ship. On the proper circulation of the air across and through the compartments, much depended for the success of the refrigeration, the other important element being the quality of the air—that is, its temperature and dryness.

The efficiency of all compressd air refrigeration depends largely on the dryness of the expanded air, but particularly so in this system, where the expanded air is exhausted directly into the cold rooms and comes in direct contact with the cargo. The compressed air passed through a dryer on its passage from the compressor to the expander, the moisture held in suspension in the air being precipitated to the bottom of the dryer and drained off. An excess of moisture in the air caused the ports and passages of the discharge valves of the expander to clog up with frozen snow and the snow to be carried along and deposited in the trunks, passages, openings and cold rooms, from which it was removed with difficulty, to say nothing of the injurious effects on the eggs, which re-

quire for their best preservation not only air of constantly even temperature, but air of exceptional dryness and free of moisture.

The trouble due to moisture held in suspension by the compressed air, and not wholly precipitated and removed in the dryer, is never entirely lacking in this system of refrigeration, but a considerable increase over normal in the amount of snow deposited in the trunks and exhaust valve passages led to an investigation as to the cause.

The air compressor cylinder wall and heads were jacketed for water circulation. Clearance depressions for nuts on piston rods projected into the water jacket, and the circulation of the water had worn and eroded away the metal on these projections until the water entered the air compressor cylinder on each air suction stroke and was present in such quantities as to freeze and block the ports and passages of the exhaust valve of the compressor. Repairs were made as follows:

The piston was removed from the cylinder and the projecting bosses in the water jacket bored out. Brass pieces were machined with depressions for the nuts, as before, and with a small flange. These pieces were driven in the head and further secured with a 5/16-inch machine screw through the flange into the head. The follower plate of the air compressor piston was counterbored to provide clearance for the flange projection. A water pressure was put on the jacket and, everything being tight, the machine was assembled and no further trouble was experienced from excessive moisture in the compressed air.

J. E. Cleary.

Philadelphia, Pa.

Damaged Bow of the Steamer *Princess Victoria* after Sinking the *Admiral Sampson* near Seattle, August 26

Damage to the S. S. Princess Victoria

The unusual photograph accompanying this letter shows the damage done to the fast Canadian Pacific passenger liner *Princess Victoria* when she collided with and

sank the Alaska liner *Admiral Sampson* in dense fog in Puget Sound early on the morning of August 26, resulting in the loss of 11 lives. While other marine disasters in North Pacific waters have claimed more lives, few have resulted in heavier financial loss. The *Admiral Sampson*, a well found vessel of 1,336 tons net, was fully loaded with a valuable cargo and had 75 passengers for Alaskan ports. The *Princess Victoria*, which plies between Seattle and Victoria and Vancouver, B. C., has been libeled for $670,000 (£137,000), of which $500,000 (£102,500) represents the value of the *Admiral Sampson*, $150,000 (£30,800) the value of her general cargo, and the balance for baggage, etc.

When the *Princess Victoria* struck the *Admiral Sampson* on the port side abreast the after hatch, she cut many feet into the Alaska liner, inflicting a wound which caused the American steamer to sink in less than ten minutes. The photograph shows a portion of the *Sampson's* hatch combing and a part of the hatch cover held fast in the gash made in the *Victoria's* bow.

The accident occurred shortly before 6 o'clock in the morning, and the fact that but three passengers and eight of the *Sampson's* crew were lost speaks for the excellent discipline and splendid seamanship displayed. The *Victoria* picked up all the survivors found and arrived in Seattle unassisted. The *Admiral Sampson* was for years engaged in the fruit trade between New York and the West Indies. R. C. Hill.

Seattle, Wash.

An Oiler's First Experience at Sea

Upon leaving school before graduation time, the writer determined to continue his marine studies practically and see a few things before settling down ashore. With that idea I was fortunate, considering the season and my ignorance of things below, in landing a berth as oiler on a lake-style collier. She was not new, but the three engineers joined her at the same time, and so she was new to them. She carried no third assistant then.

As usual in such steamers, the after ends of the boilers helped form the forward end of the engine room. As I understand it, the underwriters do not require such vessels to install any bulkhead whatever between the boilers and engine room, thus allowing many of the boiler fittings to be installed in the engine room under direct control of the engineer.

Trouble started from the first. Someone pumped bilge water into the fresh-water tank, and we drank mud for a couple of days. As soon as the first load of coal was stowed the rudder-post started to leak a small, steady stream. Attempts were made to stop the leak, but it could not be done. Then the bilge pumps refused duty and were repeatedly overhauled; but probably because the seat of the trouble was not looked for, they still balked. Next, one of the ash hoppers got out of order and repeatedly washed ashes into the bilges. As far as I remember, the other hopper was mostly ornamental. But both had their doses of overhauls, which, of course, made things worse, instead of better.

This was all fine experience for a school-boy looking for such; but it was pretty plain to see that no time was given us in port to have things fixed up properly, since it was always a case of rush to get in and rush to get out.

Things went along like that for a few trips, when one night, north-bound, the 8—12 watch got tangled up with the ash hopper and washed the ashes from four fires into the bilges. As I said before, the bilge pumps were not performing and the ballast pump was put on that job until the proper pumps could be overhauled again. The 8—12 watch fixed things up the best they could, and left the second assistant and me in charge.

About 1 A. M. I notified the second assistant that the bilge water was not being pumped out, although the pump was working. He and I worked on the pumps; but still the water rose. The first assistant was called, and got to work on the ballast pump. Bonnets were removed and replaced, again removed and replaced, the result being a fine collection of rags, waste, nuts, clinker, coal, sticks, etc., enough to block the injection.

By the time the pumps were cleared the fireroom floor plates were washing around and the bilges were filling up with bunker coal. However, the bunker openings were soon stopped up, but not until all the bilge suctions were hopelessly clogged. This made it necessary to remove manifold bonnets and break flange connections—all under water—to let the pumps work. When we started on those jobs the water was like ink and comfortably warm. The course had been changed to the nearest harbor, bringing the sea abeam and throwing the water around the engine room like a tropical rainstorm. When the emergency suctions were finally opened the water was as black as it could get, too hot to put a foot into, and over the engine room floorplates—about 3½ feet deep. At first, tomato cans with holes in the ends were used as strainers, but finally some heavy gauze was dug out, and the cook let us have his toaster. Then we bailed by hand into the manifold, while the pump did its little through the cook's toaster. It was quite a job to keep the strainers clear, and when we anchored after making twenty-three miles in nine hours, the water was about half out.

The sailors were nearly all landsmen, and had been put to work in the fireroom to help keep steam. They stuck to their job in fine shape, although they were washed around like corks and bruised by rolling lumps of coal. No Ethiopian was ever blacker than we were when it was time to wash up.

The water service had been shut off early in the fun; but still the water poured in. It came only from the leak in the rudder post, and the leak left in the hopper when the other watch finished overhauling it. The bunker coal got into the bilges because the floor plates were not screwed down. Loose planks were the only means provided to keep coal in the bunkers and out of the fireroom, and the openings themselves were large. There was an absolutely clear space from the bulkhead between the fireroom and the hold to the after-peak tank, allowing anything getting into the fireroom bilge to be washed to the suctions under the thrust.

Needless to say, as soon as the cargo was discharged we went to dry-dock for repairs; but the stern-post still leaked when the next cargo was dumped into her. If there is a lesson to be gained from this experience, it might be that haste makes waste with things afloat as well as with things ashore. Oiler.

Duties of Chief Engineers of Vessels Passing Through the Panama Canal Locks.—According to an order issued on August 14 by Col. Goethals, governor of the Canal Zone, in future in addition to the regular engineer officers of the watch, the chief engineer of all ships shall remain on duty in the engine room during the approach of the vessel to and while passing through the Panama Canal locks. It shall be his principal duty to see that signals from the bridge for the operation of the engines are understood and correctly and promptly answered.

Marine Articles in the Engineering Press

Abstract of an Important Article on Suction Between Passing Ships—Details of Some of the Large Shipyards and Engine Works in Great Britain

The Handling of Coal at the Head of the Great Lakes.—By G. H. Hutchinson. The author traces briefly the growth of the handling of coal on the Great Lakes and gives step by step the gradual development of the mechanical coal-handling devices from the simple beginning to the present elaborate installations. Various installations and methods of handling, etc., are described and a brief comparison of the electrically operated plants of 1902 and 1913 are given, concluding with a description of various clamshell buckets, methods of screening and reloading for rail shipment, together with the conditions relating to the handling of coal. 41 illustrations. 11,300 words.—*The Journal of the American Society of Mechanical Engineers,* August.

Safety at Sea.—By Captain Armistead Rust, U. S. Navy. In discussing accidents at sea, particularly the *Empress of Ireland* disaster, the author proposes a plan to systematize navigation, which in his opinion would provide greater safety than any attempts to build unsinkable ships. The system involves the establishment of a series of tracks for oppositely bound ships with a *safety zone* between; this, together with cross courses, forming *danger zones,* and a convenient and simple system of nomenclature plotted on the chart, further involves the use of a low-powered wireless apparatus for use in transmitting the vessel's location, according to the chart, giving her direction and speed. By the use of a suitable standard code and chart, as proposed, this message would consist of about six figures following the *zone letter;* in fact, on special occasions the *zone letter* is sufficient. An appendix includes extracts from the report of the Commission of Inquiry into the casualty to the British steamship *Empress of Ireland,* which sank after collision with the Norwegian steamer *Storstad,* in the St. Lawrence River, on May 29, 1914. The article also includes a description of a substitute for Lord Kelvin's sounding tube, which gives very satisfactory results and is inexpensive. 1 illustration. 6,000 words.—*United States Naval Institute Proceedings,* September-October.

Some Swedish and Danish Oil Engines.—The Hexa marine oil engine, introduced into England by the firm of Sophus Berendsen, Ltd., London, works on the hot bulb principle. The main bearings, which are fitted with ring lubrication, are entirely outside the crank cases, so that they can be easily adjusted and compression is not affected by leakage from worn bearings. Another interesting feature of the engine is found in the design of the fuel pump, which is operated through a bell-crank and eccentric off the crank-shaft. The end of the bell-crank carries a sliding block which engages with the pump plunger. The slide, however, has a small inclined portion, so designed that, at a certain speed the sliding block, by virtue of its momentum, will be thrown up too far to engage with the pump plunger. A four-cylinder, four-cycle engine of 42 brake horsepower is also described and, because of its overhead valve arrangements, approaches Diesel engine lines in general appearance. An interesting feature of this design is in driving the pumps by rocker arms off the connecting rod. Two other types, handled by the same firm, are described, but neither presents any features that vary greatly from regular practice. The first, a Diesel type, has an air compressor similar to those of Messrs. Burmeister & Wain. The last engine described is of the L-head, four-cycle, hot-bulb type, designed for agricultural work. 10 illustrations. 1,780 words.—*The Engineer,* September 18.

Suction Between Passing Ships.—By Sidney A. Reeve, M. E. Defining suction as three distinct and independent hydraulic phenomena associated with moving vessels and tracing its historical development as such, the author explains why suction has not been given as the cause for various collisions. To warn pilots, however, as to the general conditions under which suction is liable to occur and as to where a larger margin of caution than usual is needed, the author discusses briefly the various parts of theoretical hydraulics necessary to give a qualitative understanding of the forces at work in suction. This discussion consists essentially of a study of stream lines, sources and sinks, showing that the source-and-sink method can be used as an exact analysis of the displacement of the sea by a passing vessel. The author's connection with the development of the theory of suction began when he used two diagrams, one on transparent cloth, investigating merely the general outline of the constrained wave. The one on transparent cloth was moved over the other to show how the suction forces were developed by these two outlines getting into and out of place. To strengthen the belief of this theory the case of the *Olympic-Hawk* collision was virtually predicted by a naval officer who was a passenger on the promenade deck of the *Olympic* and who had previously listened to a lecture by the author on the subject. To further study the subject it becomes necessary to outline ship waves and sea contours. In explaining the constrained wave, which is practically the cause of all suction collisions, it is easily seen that while almost invisible it is by far the most powerful force created by the ship's motion. In general, then, through the center of the ship's displacement are drawn two lines at 45 degrees to the ship's center line, forming quadrants fore and aft and one on each beam. Asymptotic to these lines are the approximately hyperbolic mean sea-level contours, due to the elongated form of the vessel. These hyperbolas extend indefinitely away from the ship, but all other contours are closed curves. Between the limbs of each hyperbola, ahead and astern of the ship, rises an oblique cone of water at the stem and stern. On the other hand, the depression beamwise is still more marked in extent, and it is probably this wider area of depression than of elevation that has given the name suction rather than repulsion to the phenomenon. It is also noticeable that the deepest depression does not occur directly abeam, but on both bows or quarters, where occurs a deep pocket. In explaining the interaction between two or more ships, the author describes two methods whereby this interaction may be studied graphically. This is done by superposing two diagrams, the one on the other in their relative positions on parallel courses and one overtaking the other, so that a combined set of sea contours is obtained showing the conditions met with by such an occurrence. The two methods are similar in respect to superposing,

but slightly different with respect to initial assumptions and amount of overlapping. Both show graphically, however, why collision is almost inevitable under the conditions outlined. For instance, ships might continue safely on fairly close overlapping courses, but the conditions accentuating the forces, rendered innocuous by a great depth of water, are those of a fairly sudden shoaling, the passing of a third ship, or some restrictions such as a pier, etc. These conditions obtain in practically every case, and to illustrate the point the author's concluding remarks are analyses of actual cases showing the conditions obtaining. By giving data that may reasonably be relied upon, it is shown that such a study, as outlined, helps materially in warning pilots as to what should be avoided, and, further, a more formal and reliable preventative in the form of an amendment to our international navigation laws covering the case of overtaking vessels. 16 illustrations. 22,300 words.—*Engineering,* August 7, 14 and 21.

Föttinger Hydraulic Transformer on the S. S. Königin Luise.—The S. S. *Königin Luise,* sister ship to the S. S. *Kaiser,* a direct turbine-driven ship, was fitted with high-speed turbines and Föttinger transformers, so that the propeller speed was 450 revolutions per minute when those of the turbine were 1,800, developing 2,745 horsepower in each turbine. The rotor of the steam turbine consisted of a Curtis wheel followed by a drum carrying thirty-two reaction stages divided up into seven groups. A centrifugal governor was fitted in connection with a servo-motor, and as a final measure of security an emergency governor of the shaft type was provided. While the general design of the transformer is the same as has often been described, there are several details that greatly simplify the assembling of the gear. There is only one secondary wheel and only one set of guide blades between this wheel and the reversing primary wheel. The simplification was possible owing to the small ratio of transformation, 4 to 1. The ratio of ahead to astern power was 70 percent. The first ahead secondary wheel, and with it all primary and secondary wheels, were made in one piece, which permitted a very simple method of erection. After a detailed description of the transformer and its operation, the main steam and water connections throughout the system are described with the help of a diagram of connections. A very complete table is given showing the heat distribution, horsepowers, efficiencies, etc. In conclusion the article gives a table showing a comparison of the main particulars and trial data, etc., for three other vessels and the *Königin Luise,* all having different forms of turbine installations. 6 illustrations. 3,500 words.—*The Engineer,* September 11.

Emergency Repairs to U. S. S. Walke.—By Lieut. Commander F. T. Evans, U. S. Navy. After the passage of the reserve torpedo flotilla, U. S. Atlantic Fleet, from New Orleans to Garden Key in March of this year, it was discovered that the after trimming tank of the *Walke,* Second Division, was carrying a heavy pressure of air, as shown by the leakage of air around some rivets in the deck of that compartment. Examination by a diver showed that there was a jagged hole in the bottom of the adjacent compartment about a foot and a half long and a foot wide, situated abaft the forward strut and between its legs. It was decided to pump out the compartment, after covering the hole with a collision mat, drill the plating around the hole and bolt on a patch. All of this was successfully carried out except the use of a collision mat, which failed because the hole was situated so close to the struts that a good placement was impossible. A wooden patch was made, however, 24 by 33 inches, of double-crossed inch boards and padded on its bearing surface with several thicknesses of "fear-naught," which in turn was covered with two thicknesses of No. 8 duck. The time for the actual repairs was about thirty-one hours. 4 illustrations. 1,740 words.—*United States Naval Institute Proceedings,* September-October.

Typical Ships—An Oil Tanker.—The vessel chosen to illustrate the oil tank class of ships is the *San Jeronimo,* which has just been built by William Doxford & Sons, Ltd., of Sunderland, for the Eagle Oil Transport Company, Ltd. The ship is 525 feet long by 66 feet 6 inches beam and 34 feet molded depth, and has a deadweight carrying capacity of 15,570 tons on 28 feet draft. Built on the Isherwood system, the vessel is divided transversely into twelve tanks, which are further divided by a longitudinal centerline bulkhead, making twenty-four tanks for carrying bulk oil. In addition there are fourteen summer tanks spaced along the side of the expansion chamber. There are two main pump-rooms, acting as cofferdams, dividing the ship and the twelve tanks into three distinct groups. The machinery space is aft and the propelling machinery consists of one quadruple expansion engine of 4,300 indicated horsepower, giving a speed of about 11¾ knots. Steam is supplied by four boilers working at 220 pounds pressure and burning oil on the Wallsend system, combined with Howden's system of forced draft. A special feature of the *San Jeronimo* is the provision or arrangement to carry oil of the lowest flash-point with safety. 4 illustrations. 3,100 words.—*The Engineer,* September 4.

Australian Ports in Relation to Modern Ships and Shipping.—Abstract of a paper, by W. E. Adams, A. M. Inst. C. E., read before Section G of the British Association in Australia. The paper reviews the position of shipping from the standpoint of harbor authorities and commercial interests involved. Considering the enormous increase of shipping, particularly in the size of ships, the situation presents quite a problem to the port authorities of Australia, and one that calls for careful consideration. The conditions upon which the improvements depend are outlined and discussed, and to better understand the situation a comparison is given of the berths of fifteen years ago at the port of Sydney with those of to-day. Two cases of jetty construction, as tried in Sydney, are briefly described. These types are designed to meet the conditions where space is not available for longshore wharves served by low-level roads and belt railways. The author states that, though important, the class of wharf construction that will come into use in the future is very uncertain at the present time. 1,950 words.—*Engineering,* September 18.

The German Naval Architects.—At the summer meeting of the German Naval Architects, opened on May 27 at Stuttgart, the first paper read was on *Guns and Armor,* by Professor J. Rudloff, of Berlin. This paper reviewed the contest between guns and armor, and the author noted that the all-big-gun system was being given up again in favor of that of a combination of larger and smaller guns, which Germany had never abandoned. It was also pointed out that, due to the greatly increased power of the torpedo, it was anticipated that the naval battles of the future would be fought at greater distances. In a discussion of the paper it was expressed that fire superiority was the one factor of importance. It was also stated, as an argument in favor of large calibers, that large sizes of projectiles show less tendency to ricochet than smaller ones. *Experiments with Case-Hardening.*—The object in view was the combination, in a working part, of a tough core of metal encased in a sleeve of harder but brittle metal by the

superficial addition of carbon to the parts subject to wear, and an investigation as to how far the one quality suffered at the expense of the other. In conclusion the author recommended testing for particular cases to ascertain whether case-hardening or the choice of a special steel material would be more suitable for parts subject to considerable wear. A second paper, by the same author, on *Tension and Alteration of Form in Riveting in Relation to Hole Cracks,* showed that the application of excessive pressures by means of hydraulic riveters might even reduce the desirable pressure tending to bring the plates together. On May 28 the society visited the Zeppelin Works at Friedrichshafen, where the aluminum framework of a new airship was inspected and a paper was read by Count von Zeppelin on *Zeppelin Airships.* In tracing its development, the author stated that the rigid system of holding the structure together seemed to be unavoidable, and was therefore adopted. The structure, however, was considerably lightened by adopting two cars to carry the weight instead of one, which would concentrate the weight and necessitate a stronger and consequently a heavier structure. A comparison between airships and aeroplanes showed the superiority of the latter at 56 miles per hour and over, pointing out that aeroplanes traveling over long distances at low speeds were especially subject to retardation by contrary winds and that for very long distances the airship was superior to the aeroplane. An important question and one yet to be solved is that of a non-inflammable gas to take the place of hydrogen now used. A paper on *Steam Shipping on Lake Constance,* tracing its rise and development since the pioneer vessel made her first voyage ninety years ago, together with a paper on the establishment and development of the *Stuttgart Laboratories* and a description of the same, both by Fregattenkapitan Collman, concluded the programme. 7,200 words. —*The Engineer,* June 5 and 12.

French Sea Fisheries.—The productivity of the French sea fisheries is far inferior to that of the same industry in Great Britain, largely due to the circumstance that the French industry still remains in a very primitive condition from the standpoint of the craft employed. Nevertheless, these fisheries have developed remarkably at certain points on the coast, occupying a prominent place in the activities of the ports and supplying, to an important extent, the traffic on the French railways. The industry has for a long time received encouragement in the form of premiums for deep-sea fishing, chiefly cod-fishing. This, however, has caused a decline, while the fishing for fresh fish, unassisted by subventions, has developed remarkably. Statistics quoted each year by the French Admiralty Board show that since the commencement of the nineteenth century the industry has developed remarkably, but the development now reached is in no way comparable to the advances made either in the same country forty or fifty years ago, or to those which are being, and have been, made in other countries. The boats, speaking generally, are only slightly improved, because they are the property of small owners, who do not have the required capital necessary to adopt machinery or to construct larger units. The total number of boats employed in French sea fishing is about 30,000, and at the present time only 270 to 280 of the whole fleet are steamboats. The steam fleet comprises three types—the trawlers, the line fishing smacks and the drifters. The trawlers are generally constructed of iron, and are of 300 to 400 gross tons, fitted with 400 to 600 horsepower. These are usually provided with holds containing ice, although, more rarely, refrigerating apparatus. These boats are still frequently constructed in England for French owners. In order to diminish first cost, certain boats have been fitted with internal combustion engines up to 200 horsepower, to actuate the screw, with the same type of engine up to 30 horsepower, to work the capstan. In conclusion, while the sea fishing in France is still greatly behind hand, under the influence of the steam trawler it is being industrialized, and there is a gradual introduction of the fixed wage, as adopted in ordinary works on land. Altogether the expenses of the French Government, of subventions, bounties, etc., exceed 21 percent of the value of the total production of this branch of the sea-fishing industry.—2,700 words.—*Engineering,* July 31.

Harbor Construction at Frankfort-on-Main.—Frankfort, though counted among the Rhine harbors, as is also Offenbach, lies on the Main, which drains an area of 10,650 square miles. The canalization of this latter river between Frankfort and the Rhine presented difficulties, there being insufficient depth of water and a considerable fall on this section of the river. After abandoning the plan of constructing an independent canal between Frankfort and Mayence, the Prussian State decided to undertake the work of making the Main navigable for large vessels. This was accomplished by the construction of six weirs, which deal with an aggregate fall of 34 feet 2 inches in 20.5 miles. The regulation allows the passage of vessels of 8 feet 3 inches draft and 1,000 tons capacity, and a further weir has been constructed above Frankfort, so as to make Offenbach also accessible for Rhine craft. When the Frankfort west harbor was built, the city undertook that it should provide a safe harbor for vessels, when this waterway became unnavigable because of the weirs being rendered inoperative by ice or repairs, allowing the vessels to enter even at the lowest water level. Although no such undertaking exists for the east harbor, large portions of it will offer the same advantages to shipping. The entrance to the lower or west harbor first leads into a triangular basin, from which branch off the commercial dock basin and the lower industrial dock basin. This outer triangular basin not only serves as a waiting place and a means of establishing connection between the two dock basins, but it is also used for turning vessels; its dimensions are such that a circle can be inscribed having a diameter of almost 500 feet. The commercial dock basin has a breadth of 246 feet or 7½ ships' breadth, all told, of about 33 feet. The breadth of the industrial harbors, of which there are three, does not require to be so large and is fixed at 131 feet and 164 feet. The harbors as enlarged will have an aggregate wharf accommodation of 8.7 miles in length. Including 3.1 miles of old shore accommodation, Frankfort will thus have about 12.5 miles of wharf accommodation available. All quay and other structural foundations have been laid deep enough to increase the depth in the inner basins from 8 feet 10 inches to 9 feet 10 inches if such should be deemed expedient in future. The quay walls at the entrances and sides of the dock basins are nearly vertical and the foundations are of concrete, the wall on the outer side being coated with basalt, and the crown finished with granite blocks. There are steps at varying distances and ladders between them, so that at least a set of steps or a ladder corresponds with each ship's length. Both steps and ladder are in the quay wall thickness. The railway communications, as well as the connection of the new harbor with the town, are on the same comprehensive basis as the rest and some very important structures also in the way of bridge-building are already more or less advanced. The bridges and viaducts come under two heads—the bridging of the streets

and railways and the bridges over the Main and the harbor basins. The Frankfort harbor authorities have expressed their determination to make their harbor as complete and efficient as possible. The traffic in 1911 amounted to an aggregate of 1,990,248 tons, against 1,840,704 tons in 1910. 7 illustrations. 2,500 words.—*Engineering,* August 28.

North-Eastern Marine Engineering Company's Works, Wallsend.—The company's establishments, one at Sunderland, where 1,200 men are now employed, and another at Northumberland, where 2,000 men are employed, both carry out the same operations and are assisted by the company's Northumberland forge, which produces per annum about 2,500 tons of forgings of all classes. The average output per annum of the combined concern shows a collective horsepower, of marine engines built, of 95,000. In designing the machinery built every effort is made to adhere to standards, varying only in the power to be developed. The main buildings, at Wallsend, are constructed on a fairly steep slope stretching from the railway sidings to the river. The roof is level and the floor of the shops terraced in three great steps. The location of the various shops greatly simplifies their convergence to the engine-erecting shop, which is laid with a concrete base for the building up of the engines. The practice at the works is to transfer from the erecting-shop to the ship complete triple expansion engines up to 2,000 horsepower. In the case of larger engines, the bed-plate, crank-shaft, connecting-rods, eccentric rods, links and columns are lowered into position first. All cylinders, even in quadruple expansion engines, are placed in one lift. This is made possible by the crane equipment, which is quite as complete as the machinery equipment in the various shops. A 150-ton cantilever crane handles the machinery, etc., alongside the ships, and is capable of lifting loads into two ships lying side by side along the berth. 7 illustrations. 3,500 words. —*Engineering,* July 3.

The New Armstrong Naval Shipbuilding Yard.—The development in the design of warships has necessitated the building of a new yard by Sir W. G. Armstrong, Whitworth & Company, at Walker. While the Elswick Yard, in itself, is adequate for the present and considerable future advance, the width between piers on the swing-bridge, spanning the River Tyne, sets a limit to the beam of vessels built there. The total area of the new site is 83 acres and 4,115,000 cubic yards of earth were excavated so that the yard proper might be on one level. The river frontage is 4,376 feet and it is on the convex side of a bend in the river, enabling the berths to be built almost parallel to the river for convenience in launching. There are nine berths, ranging in length from 1,000 feet to 500 feet. The river was dredged for a width of 100 feet alongside the quay, to a depth of 30 feet, involving the removal of half a million tons of material. The quay wall and the jetties between berths are of ferro-concrete work. To strengthen the keel and bilge blocks in the berths, 4,500 pitch-pine piles 14 inches square were driven to a depth of 18 feet. Traveling tower cranes on the jetties lift 10 tons at a radius of 60 feet and 5 tons at a radius of 120 feet, while the clear height of lift above rail-level is 90 feet. Electric transformer sub-stations are built into the jetties to reduce the length of low-tension leads. The platers' shed is as close to the berths as possible, and the departments for fitting out are arranged opposite the quay wall, where two or three battleships may be simultaneously berthed. Material is conveyed to racks at the rear of the platers' shed, from the railroad, by means of three successive sidings, having inclines of 1 in 30. The molding loft is built over the platers' shed and is 320 feet by 98 feet. To meet the requirements of drilling, which is largely taking the place of punching in connection with high tensile steel, machines are provided for carrying high-speed radial drills capable of completing the work on the longest plates without moving them. The furnaces throughout the shops are all gas-fired. Throughout the works there are about 10 miles of railway track, with nearly 170 points and crossings. 1 illustration. 2,800 words.—*Engineering,* July 3.

The Wallsend Slipway & Engineering Works.—Few, if any, of the engineering factories in the Northeast Coast district have made more rapid progress in recent years, alike in regard to the area of shops and importance of works done, than those of the Wallsend Slipway & Engineering Company. It is a striking fact that, whereas in the first twenty years of the company's history the output was 432,273 horsepower, it has been 1,077,685 horsepower during the past fifteen years. Up to 1896 the largest engines made were of 4,500 horsepower, since then sets of engines of 70,000 to 80,000 horsepower have been completed. The increase in the volume and value of the work done is due to the improved mechanical equipment as well as to the type of work undertaken. As regards the equipment of the works, the largest set of turbine engines yet completed for a British warship was despatched from the Wallsend Works within eleven months from the placing of the contract. Notable changes in the layout of the plant, regardless of the increases in size, are the elimination of the slipways and the substitution of a hammer-head electric crane on the river side for the old 80-ton sheer legs on the Willington Gut jetty. Various additions have been made in the engine shops for dealing with the largest turbines that are ever likely to be designed. One of these is a 60-inch lathe for rotor-turning work, having a bed 66 feet 3 inches in length; this, in addition to the older tool, which takes work 18 feet in diameter and 50 feet long. For the erection and testing of turbines there has been fitted a bed consisting of twenty-three cast-iron girders, of a collective weight of 55 tons, insuring an absolutely true surface. Besides the turbine work, the firm shows the same progressiveness in the construction of Diesel engines, and both triple and quadruple expansion reciprocating engines. The boiler shop has also been extended. Twenty years ago the average number of boilers per annum was 30; now the number is 77. As to the equipment, the plate-edge planer takes plates 35 feet long and the vertical bending rolls deal with plates 12 feet 6 inches wide, while the hydraulic riveting machine has a gap of 12 feet. Another addition is a 6-inch spindle, high-speed drilling machine, for nickel-steel plates. At the end of the boiler shop there has been built an annex for electro-zincing boiler tubes. This plant includes a three-phase motor and special dynamo by Messrs. Clarke, Chapman & Company. The iron foundry deals with castings up to 30 tons. An interesting feature is that, although the works are entirely run by electric current from the public supply works, the recently built shops are lighted by high-pressure gas, one advantage being a steadier general illumination. The jetties built along the river front on each side of the graving dock take ships 800 feet long, while the hammer-head crane, built by Sir W. Arrol & Company, has sufficient outreach to command two ships of fairly wide beam. The railway lines to the jetties pass through all the shops, so that the transport of material to the ships is a simple matter. 8 illustrations. 2,300 words.—*Engineering,* July 3.

New Books for the Marine Engineer's Library

A German Author Discusses the Strength of Ships—Notes on Refrigeration—An Elementary Manual of the Steam Engine

THE MODERN WARSHIP. By Edward L. Attwood. Size, 4¾ by 6½ inches. Pages, 146. Illustrations, 17. Cambridge, 1913: The University Press and New York, 1913: G. P. Putnams Sons. Price, 40 cents.

As one of the Cambridge manuals of science and literature, this book shows briefly how a modern warship, costing, say, two millions sterling, grows in the short space of six hundred days from a design on paper to a powerful unit in the navy. The book is written from the naval architect's point of view by a member of the Royal Corps of Naval Constructors, and will be of much interest to the lay reader who desires to obtain a general knowledge of a modern warship. For scientific information on the same subject, the reader should consult Mr. Attwood's standard text-book on warships.

FESTIGKEIT DER SCHIFFE (Strength of Ships). By Felix Pietzker. Size, 6⅜ by 9½ inches. Pages, 224. Illustrations, 140. Berlin, Germany, 1914: Ernst Siegfried Mittler & Son. Price, $2.00.

The author has set himself the task of showing how far calculations can nowadays elucidate the strength conditions of ships' hulls and what practical conclusions can be drawn therefrom. He devotes the first third of the book to the fundamental laws of strength of materials, as applicable to ships, and the last two-thirds to practical applications of these laws, aiming particularly to make clear how far calculation is possible and to what degree of accuracy. In detail the first part is divided into six chapters, dealing successively with methods of applying laws of strength of materials; fundamental conceptions of structural material of ships; equivalent girder of ships; surfaces loaded by water pressure; quality of material and riveting. The second part is in turn devoted to longitudinal and transverse main framing; special requirements of docking; members locally strained by water pressure and local forces and weights. The book is very clearly arranged with a large number of thoroughly practical examples, ably supplemented by the diagrammatical illustrations, which should make the little volume a handy guide and reference book to the designing naval architect. The publishers have assisted the author in producing a book of value by well executed tables and diagrams, clear print and good paper, that compare very favorably with other technical books.

HENDRICKS' COMMERCIAL REGISTER OF THE UNITED STATES FOR BUYERS AND SELLERS. Twenty-third edition. Size, 7½ by 10 inches. Pages, 1,600. New York, 1914: S. E. Hendricks Company. Price, $10.00

The twenty-third annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers, which has just been issued, is by far the most complete edition of this useful work that has been published. Many new features have been added; thousands of trade names and titles of identification have been inserted, and numerous duplications expunged. "The Assistant Buyer," formerly published by the Sullivan System, has been incorporated with it, and the entire work has been thoroughly revised and improved in every detail. This publication lists manufacturers of everything made from iron, steel, brass, bronze, copper, aluminum, platinum, zinc, lead, etc., whether cast, rolled, drawn, pressed or forged, including bar, plate, sheet, wire, structural and other shapes; pipe, tubes, bands, hoops, high speed, high carbon, tool and other high grade steels, bolts, nails, nuts, rivets, screws, rods, spikes, chains, shafting, etc., and castings of every description, from all metals, including every machine, tool, furnace, etc., required in their production. It numbers some 1,600 pages and contains about 350,000 names and addresses, with upwards of 45,000 business classifications, while 138 pages are required to index its contents. It is used extensively throughout the United States and many foreign countries for purchasing purposes by corporations, governments, associations, manufacturers, exporters, puchasing agents and sales managers.

THE POCKETBOOK OF REFRIGERATION AND ICE-MAKING. Sixth edition. Edited by A. J. Wallis-Taylor. Size, 4½ by 6¾ inches. Pages, 215. Illustrations, 37. London, 1914: Crosby, Lockwood & Son. Price, 3/6 net.

In recent years refrigeration has become an important feature of modern passenger and freight ships, particularly in those which carry perishable cargoes, and the marine engineer is constantly in need of information regarding the general principles of refrigeration and the operation of refrigerating machinery. In this connection this handbook will be found useful, as it presents such information in condensed form for ready reference. The book is divided into six sections dealing with refrigeration in general, cold storage, ice-making and storing ice, insulation, testing and management of refrigerating machinery and general memoranda, tables, etc. Some sixteen pages of new matter have been added to this edition, as well as several new illustrations.

ELEMENTARY MANUAL OF THE STEAM ENGINE. By Ernest V. Lallier. Size, 5 by 7⅝ inches. Pages, 266. Illustrations, 102. New York, 1913: D. Van Nostrand Company. Price, $2.00 net.

In order to help students of steam engineering who lack practical experience, and operating engineers who lack theoretical instruction, the author has compiled a manual which presents the fundamental principles of the use of steam and steam engines in an elementary manner. While the book was written for a special class of readers, the author's experience as an instructor in engineering has made it possible for him to accomplish his task in a very efficient manner. The subjects covered are reciprocating steam engines, governors, engine calculations, the indicator, heat, boilers, pumps, Corliss engines, pipes and fittings, rotary engines, internal combustion engines and lubrication. Numerical examples are used freely throughout the book, and at the end of each chapter are representative questions which will enable the reader to gage his knowledge of the text.

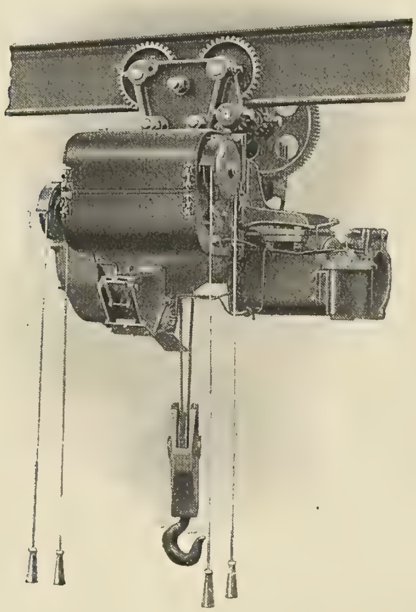
THE TECHNICAL PAPERS of Ariya Inokuty, professor of mechanical engineering in the College of Engineering, Tokyo Imperial University, and professor in the Naval Staff College of Japan, have been compiled and published by the Celebration Committee for the occasion of Prof. Inokuty's twenty-years' occupancy of the chair of engineering, Tokyo Imperial University. Thirty-two papers have been printed in English and eleven in Japanese, all profusely illustrated, and published in a handsome volume of some 600 pages. The volume is a lasting memorial to Prof. Inokuty's great technical genius and a fitting tribute to a life of inestimable usefulness.

ENGINEERING SPECIALTIES

Traveling Electric Hoist

A traveling electric hoist designed to handle all kinds of material of every weight, size and description, in and about manufacturing plants, is being manufactured by the Pawling & Harnischfeger Company, Milwaukee, Wis. Even where large cranes are used, the hoist, which runs on the lower flanges of an I-beam attached to the ceiling or supported by frames, has the advantage of getting into corners or irregular areas which cannot always be reached by a large, heavy crane.

The hoist is symmetrical in appearance, the drum being in the center, surrounded by a frame of cast steel with the motor fastened to one side and the gear case to the other



side. The drum is flanged and provided with grooves to a depth equal to the diameter of the rope, so that the rope is not apt to jump the grooves if the pull becomes sidewise. The rope is of plow steel, designed with a factor of safety of five. The lift, for type V, as illustrated, is 15 feet, unless otherwise specified. The hoist gears and the load brake are enclosed in a dust and oil-tight gear case and thoroughly lubricated by splash oil. Worm gearing has been avoided and the drive consists exclusively of spur gears. All gears are of cast steel, all pinions of forged steel hardened, and all bearings are bronze bushed. The load brake runs at a moderate speed and is so located that the fewest number of parts are interposed between it and the drum. The load is claimed to be automatically sustained at all times, so that it cannot run down through carelessness of the operator or interruption of the current, but must be let down by reversing the motor.

The truck is bolted to the cast steel drum frame and is provided with drop-forged and roller-bushed truck wheels. On motor-driven trucks, all four truck wheels are driven, which facilitates running over short curves. A substantial, asbestos-lined, clam-shell solenoid brake is provided for the purpose of bringing the motor to a prompt stop after the controller has been returned to the off-position. If this motor brake were omitted, it is claimed that the hook, after the power is shut off, would drift to such an extent as to make accurate spotting of the load impossible. When the bottom block reaches the highest position it strikes a limit switch which interrupts the motor current and brings the motor to a quick stop by means of the motor brake. The load cannot, then, be hoisted any further, but it can be lowered in the usual manner and the limit switch resets automatically.

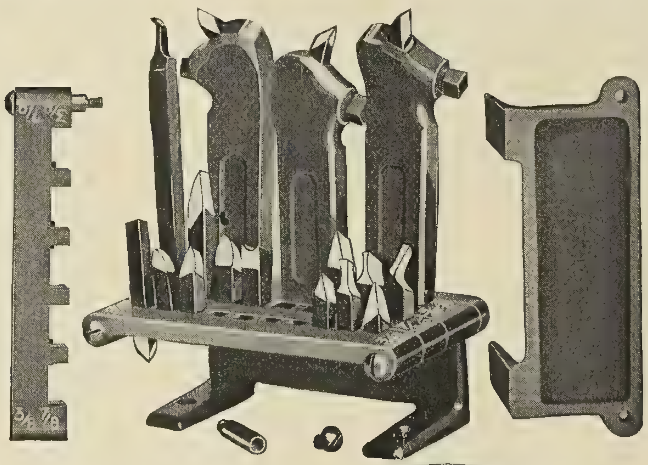
The direct current motors used in these hoists are made by the same company and are especially designed for crane service. All motors are completely enclosed and can be operated outdoors. Direct current motors can be furnished for 110, 220, 500 and 600 volts, while alternating current motors can be furnished for 2 or 3 phase, 25 or 60 cycle, 110 to 550 volts, and are of the slip ring type.

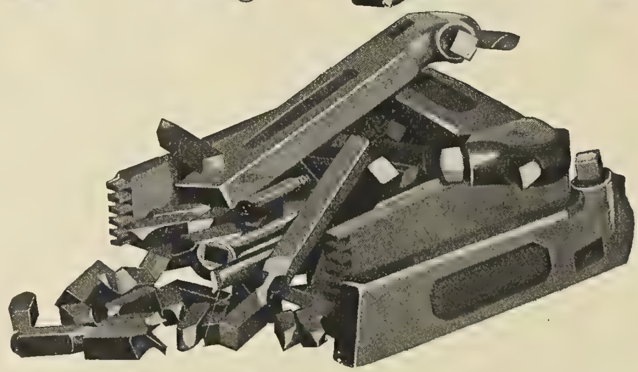
The hoists are fitted with controllers of the drum type, made entirely of non-combustible material. These controllers are provided with a spring return, which automatically shuts off the power when the operating rope is released. The hoists are further provided with current collectors and are wired according to the rules of the National Board of Fire Underwriters.

These hoists are furnished, for use in a monorail system, with or without following cages for the operator. They are also arranged for hook suspension and may be provided with magnets, hooks, etc., for any particular purposes.

A Convenient Tool Rack

A tool rack, providing a place convenient for the tools, that it is made to hold and that automatically arranges the tools as to size when they are put into the rack, is being manufactured by C. H. Driver, Racine, Wis. The





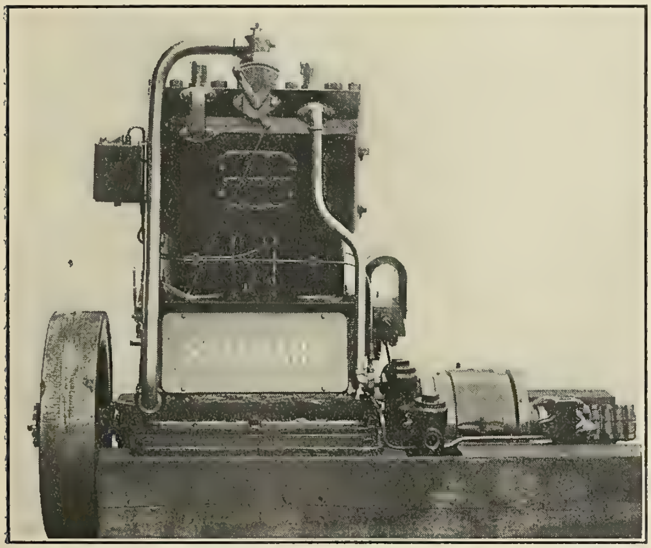
rack is made for the purpose of holding tools for lathes, planers, shapers and automatic machines, also for holding drills, reamers, taps and mandrels, most of which are used in boiler and machine shops.

The rack is made up in sections affording an arrange-

ment by which racks can be made up to hold any desired shape or size of tools or holders and to hold as many of the different tools as are required for each machine that is to be equipped with them. Each section is made so that it will hold only the size of tools that it is made for, so that larger tools will not fit in the rack and smaller tools will fall through. In this way the tools are kept conveniently and systematically and are automatically arranged according to size. The racks can be fastened on the side wall, posts, tool boards or any convenient place on the machines that are to be equipped with them. This not only furnishes a means of keeping tools, etc., within easy reach and in a compact form, but it greatly reduces the chance of tools being lost and finding their way to the scrap heap.

Standard Kerosene (Paraffin) Engine

One of the principal drawbacks to the use of the Diesel or other types of heavy-oil engines for small powers is the high first cost. In small boats where less than 300 horsepower is used, only in a few cases are the engines in operation enough hours in the course of a year to make a saving in fuel which would offset the increased



interest on the first cost of the investment, the depreciation, etc., of the expensive heavy oil engines. With this belief in mind, the Standard Motor Construction Company, Jersey City, N. J., has developed an oil engine which can run successfully on kerosene (paraffin), but which, at the same time, has incorporated in it most of the features found in the Standard gasolene (petrol) engine. These features include low fuel consumption, low first cost and flexibility. The basic principles of design and construction which have proved successful in the Standard gasolene (petrol) engine are maintained in the Standard oil engine. The regular table of weights, dimensions and sizes covering the Standard gasolene (petrol) engines can be used on all sizes for the Standard oil engine, as they are primarily the same. The revolutions are the same and the same horsepower is obtained for the same revolutions. No hot bulbs are required and the engine may be started on gasolene (petrol) or with a small torch or electric mat. Only a few seconds' time is required when starting to get enough heat in the engine for operation on kerosene (paraffin). The ignition in the oil engine is the same low tension make-and-brake as in the Standard gasolene (petrol) engine. The two-cylinder engine shown in the illustration is rated at 16 to 18 horsepower, the diameter of the cylinders being 6 inches and the stroke 8 inches.

Rotary Air Compressor

An air-cooled, rotary air compressor that can be directly connected to a high-speed electric motor or driven by a belt, and that is claimed to give a large delivery with a low power consumption, is being manufactured by the Wernicke-Hatcher Pump Company, Grand Rapids, Mich.

The pump consists essentially of a rotor and a rotor case, both of which revolve on eccentric centers; a shaft with intake and discharge ports, the rotor being keyed

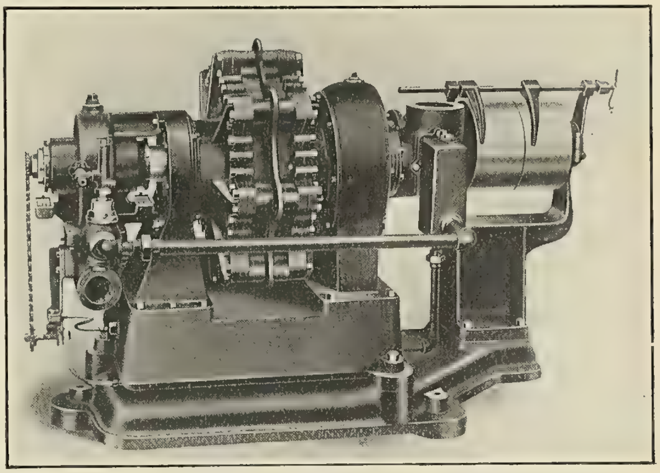


Fig. 1.—Belt-Driven Rotary Air Compressor

to the shaft; and bearings for the shaft and casing. The space between the rotor and casing is divided into a number of pockets by means of sliding vanes which pivot on shoes fitted to the face of the rotor. Each pocket is provided with an intake and a discharge valve connecting through suitable passages with the intake and discharge passages in the hollow rotor shaft.

Rotor and rotor case both revolve, one within the other, in the same direction and at the same number of revo-

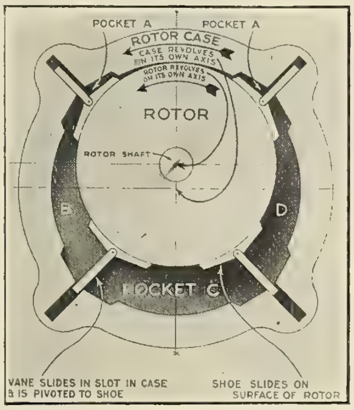


Fig. 2.—Cross Section of Rotary Compressor

lutions per minute and each on its own axis or centerline. Since the rotor and casing are eccentric, so that they practically touch at one point, it is easily seen that during one-half of a revolution the pockets are expanding and drawing in air, and during the other half revolution the pockets are contracting and compressing the air.

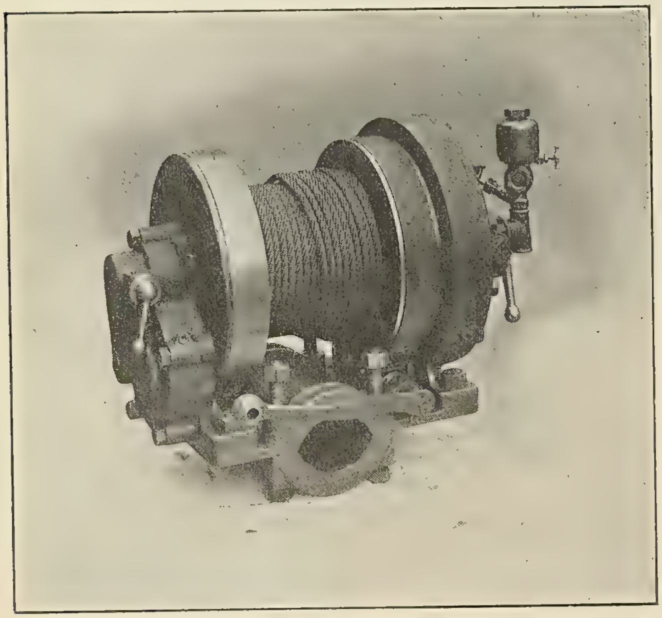
It is claimed that the cooling for this pump is very effective, since the heat of compression is practically eliminated at its source by radiation due to the very large proportion of radiating surface to air contained. Also the area of cooling surface is constant and the effective part

of it, the outer, exposed surface of the rotor, is cooled by revolving at high speed.

Many important advantages are claimed for this new principle in air compressors, such as smooth running, even wear, cool operation, large deliveries of air at high-pressures, low power consumption running and starting, light and compact, easily installed, choice of drive, efficient at all speeds up to maximum, and steady flow of air without pulsations.

The "Little Tugger" Hoist

A new type of hoist intended for light lifting work, having a capacity up to half a ton, has recently been placed on the market by the Ingersoll-Rand Company, New York. Due to its light weight, which is under 300



pounds complete, it is particularly suitable for use as a portable hoist for mines, for contract work, for manufacturing plants, for power houses and in railroad shops and shipyards, where it can be put to innumerable uses.

The main base of the hoist is arranged so that it can be bolted to a timber, and by means of a cap which comes with the hoist it can be clamped to a circular member, as a column or arm, shaft, bar or pipe. The adjustment can be made quickly. The dimensions of the hoist are 21¼ inches by 16½ inches, and the height is 20⅛ inches. The drum is 6 inches in diameter, with a space of 7 inches between flanges. This will accommodate a length of 700 feet of ¼-inch rope or 450 feet of 5/16-inch rope. The capacity is 1,000 pounds at a rope speed of 85 feet per minute and a pressure of 80 pounds. It operates with either compressed air or steam.

The motor or engine is of the reversible, square-piston type, giving four impulses per revolution of the engine. There are no dead centers and it is claimed that the "Little Tugger" will start in any position. The drum is mounted independent of the engine shaft and is operated through the medium of a clutch and gears. Safety is provided for by a powerful worm-operated band brake lined with "Raybestos."

Referring to the illustration, which shows a front view of the "Little Tugger" hoist, the engine is on the right-hand side, the gear case is on the left-hand side, and between the two are the brake and drum. The lever on the left controls the gears and clutch, the one on the right hand controls the direction of operation, and the bottom lever operates the brake. The speed of hoisting is entirely at the will of the operator. When he releases the throttle it returns automatically to central position, shutting off the power and stopping the hoist. Oftentimes the hoist will be used for haulage purposes, and the release feature enables one man to handle this class of work. He can leave the control lever and carry the rope to the car. Hoists without this feature require two men, inasmuch as the rope has to be released under power.

There are no moving parts exposed on the "Little Tugger" except the drum, all gears and shafts being covered. This is an especially desirable feature for operation in confined quarters where the light is none too good and where there is constant danger of workmen's clothes or bodies getting caught in machinery.

Shallow Water Boats

The Shallow Water Boat Company, 55 Liberty street, New York, has brought out a new system of tunnel construction for use in the operation of tunnel-stern, shallow-draft boats. The tunnel is constructed to suit the size of the propeller so that the propeller can be placed entirely above the bottom of the boat inside the tunnel. To the top of the tunnel is secured a vertical pipe of any convenient size, which is connected to an air pump by means of which the air can be exhausted from the pipe. This keeps the tunnel and pipe constantly filled with water, regardless of the actual draft of the boat, so that the propeller is entirely submerged as long as a vacuum is maintained in the stand pipe. This system is claimed to be efficient and economical in operation and to be applicable to any boat of the shallow draft type.

Personal

Harry Gregg, of Buffalo, N. Y., has been appointed chief engineer of the steamer *Harvester,* succeeding J. M. Chapman.

Thomas J. O'Connor, formerly chief engineer of the steamship *Lackawanna,* has been appointed engineer on the municipal fire steamers of the city of Buffalo.

Theodore Silas has been appointed assistant engineer of the steamer *Frederic Du Barry,* of the Chesapeake & Potomac Steamboat Company, of Washington, D. C.

Cyrus M. Yarter, of Albany, N. Y., has been appointed chief engineer of the steamer *Ashford.* Mr. Yarter was formerly chief engineer of the steamer *Herbert J. Dolan.*

Capt. George E. Burd, U. S. N., who has been engineer officer of the New York Navy Yard, Brooklyn, N. Y., for four years, has been appointed industrial manager of the Yard.

Robert A. Mosely, of Albany, N. Y., formerly in the United States Revenue Cutter Service, has accepted a position with the Seeley Engineering Company, of New York City.

William J. Garrett has resigned as first assistant engineer of the Anchor Line steamer *Muncy* to accept a position as engineer in the new Masten Park High School at Buffalo, N. Y.

John F. Jackson, chief engineer of the steamship *Bear,* of the San Francisco & Portland Steamship Company,

and senior officer of the fleet, has been given one month's leave of absence.

Robert Paul, chief engineer of the steamship *Mongolia,* of the Pacific Mail Steamship Company, has returned to duty after a vacation of two months spent at his home in Brooklyn, N. Y.

William L. Bunker, formerly chief engineer of the steamship *Manchuria,* of the Pacific Mail Steamship Company, has accepted a position with the Great Northern Steamship Company.

Robert Keefe, formerly first assistant engineer of the Anchor Line passenger steamer *Octarara,* has been promoted to the position of chief engineer of the steamer *Susquehanna* of the same line.

George R. Smith, of Norfolk, Va., has been appointed chief engineer of the steamer *St. Johns,* of the Chesapeake & Potomac Steamboat Company, Washington, D. C., taking the place of E. Fitzgerald, resigned.

Ramsay Farley, formerly second assistant engineer of the British steamer *Persia,* of the Pacific Mail Steamship Company, has been appointed first assistant engineer of the steamship *Peru* of the same company.

Robert E. Mullane, formerly treasurer of the D. T. Williams Valve Company, Cincinnati, Ohio, has been elected president of the company, succeeding Mr. D. T. Williams, whose resignation took effect September 21.

Arthur Robinson, formerly assistant engineer of the steamer *St. Johns,* has been transferred to the steamer *Wakefield,* of the Chesapeake & Potomac Steamboat Company, and promoted to the position of chief engineer.

Louis L. Bernier, manager of the Multicoil Company, 78 Broad street, New York City, has been appointed New York agent for the Kingsford Foundry & Machine Works, Oswego, N. Y., builders of marine and stationary boilers.

John B. Morris, first assistant engineer of the steamship *Columbian,* of the American-Hawaiian Steamship Company, has resigned to accepted a position on one of the new turbine boats of the Great Northern Company, which will operate on the Pacific coast.

H. V. Barbarie has resumed his position as chief engineer of the steamship *China,* of the Pacific Mail Steamship Company, while Max Oettle, who acted in that capacity on the last voyage of the vessel, has been transferred to shore duty with Superintendent Chisholm.

Charles J. Koen, for several years chief engineer of the Yukon River boats of the Northern Navigation Company, has been appointed postmaster at St. Michael, Alaska. Mr. Koen has also been appointed United States Commissioner for the Second Judicial District of Alaska.

Arthur Curtis, formerly employed on the tug *Joseph Arnold,* of the Albany Towing Company, Albany, N. Y., has been transferred to the position of first assistant engineer of the steamer *George N. Southwick.* The tug *Joseph Arnold* has been laid up at Schodack, N. Y., for the season.

Andrew Fletcher, president of the W. & A. Fletcher Company, Hoboken, N. J., ship and engine builders, has been elected a director of the American Locomotive Company to fill the vacancy caused by the resignation of Charles M. Schwab, president of the Bethlehem Steel Company.

Samuel Wheatland, of Chicago, Ill., is chief engineer of the lake tug *M. A. Knapp,* of Duluth, Minn. The tug was pontooned and brought through the Erie Canal to work on the Hudson River for the Great Lakes Dredge & Dock Company. Charles Hunt, of Rensselaer, N. Y., is first assistant engineer of the tug.

William Hyde, who has been chief engineer of the tug *W. B. McCollough* through the summer, has accepted a position in the Cornell shops at Rondout, N. Y., as the tug has been laid up in Rondout for the season. Captain Charles Scott, who had charge of the *W. B. McCollough,* will act as auxiliary captain of the Albany Towing Company.

George C. Shepard, formerly chief engineer of the American-Hawaiian Steamship Company, New York, has been appointed general manager of the Poole Engineering & Machine Company, Baltimore, Md. Before his association with the American-Hawaiian Steamship Company, Mr. Shepard was chief engineer of the marine department of the Maryland Steel Company, Sparrows Point, Md.

Charles Buchanan, principal of the chief ship surveyors' staff of Lloyd's Register, London, has been forced on account of his health to give up active service. Mr. Buchanan has been in the service of Lloyds Register for over thirty-four years, twenty-three of which have been spent in the head office in London. For seven years prior to the death a year ago of Dr. Samuel J. P. Tearle, chief ship surveyor of Lloyds, Mr. Buchanan held the position of assistant chief ship surveyor. Mr. Buchanan is a native of Dumbarton and served his apprenticeship in that town. In 1880, when he joined Lloyds Register as a surveyor, he held the position of chief draftsman in the shipyard of Archibald McMillan & Son, Dumbarton. For the first twelve years of his association with Lloyds Register, he represented the society in various districts, including Barrow, Stockton, Middlesbrough, Hartlepool, Sunderland and Newcastle, after which he was transferred to the London office.

Obituary

A. P. Hillman, Joseph Drennon and D. J. Reid, engineers on the steamship *Francis H. Leggett,* lost their lives when that vessel foundered off the coast of Oregon, September 18.

Sir Stephen Furness, Bart., chairman of Messrs. Furness, Withy & Company, was killed instantly on September 6 as a result of a fall from the fifth floor of a hotel at Broadstairs, where he was staying. Sir Stephen was forty-two years old.

Andrew J. Cohen, first vice-president of the Merchant & Evans Company, Philadelphia, died from an attack of heart disease October 11, at the Hotel Knickerbocker, New York City. Mr. Cohen was chairman of the metal committee of the National Hardware Association.

John Clarke, Sr., principal of the North-East Coast Engineering Works, Hull, died July 20 at the age of 44. Mr. Clarke served his apprenticeship in the engineering trade with Messrs. Joicey, of Forthbank, Newcastle. His first experience as a sea-going engineer was with the Wilson Line. Later he served on the East Indian Mutual Line of steamers. Upon leaving sea life he became manager of the Northern Marine Engineering Works, South Shields, and was later associated with the Hull Central Dry Docks, Ltd., and the R. M. S. Packet Company, serving as superintendent engineer of the latter until he opened the North-East Coast Engineering Works.

SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

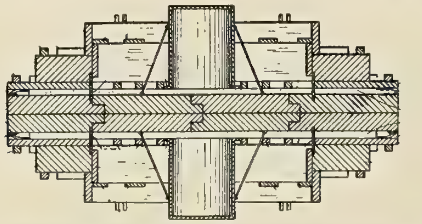
American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,104,089. AUTOMATIC SAFETY LAUNCHING DEVICE FOR LIFE-BOATS. CHARLES W. WEILAND, OF BROOKLYN, N. Y.

Claim 1.—The combination with the hull of a life-boat adapted to be launched from a ship, of a plurality of strengthening bands extending substantially from the gunwale to the keel of said life-boat, brackets mounted on said bands approximately at the bilge of said life-boat, and adapted together with said bands to distribute shocks over a large area of the said hull, and wheels mounted in said brackets and adapted to roll on the side of said ship as the said life-boat is raised or lowered, substantially as described. Four claims.

1,105,976. LIFE-SAVING RAFT. WILLIAM JACOB, OF SAN LEANDRO, CAL.

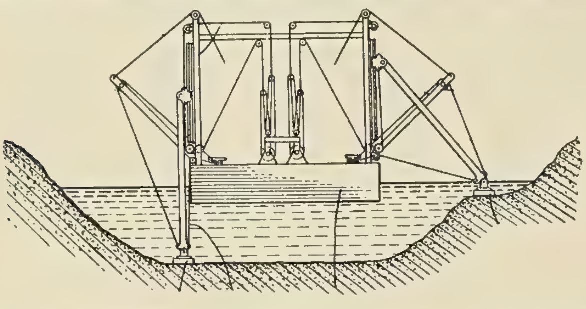
Claim 5.—A raft comprising a central platform of heavy wooden beams, strips of wood on each side of said platform, spaced apart to furnish water outlets, non-return valves in said water outlets, heavy



beams over said strips, cabin walls secured to said beams, ropes secured to the raft and floats secured to the ends of the ropes. Five claims.

1,108,001. DIGGING AND DREDGING MACHINERY. WILLIAM J. QUIMBY, OF NEW YORK, N. Y., ASSIGNOR TO THE HAYWARD COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In a retaining mechanism for dredges, and the like, the combination with an upwardly extending guide, of a swinging spud, means for pivotally and slidably connecting the inner end portion of



said spud to said guide whereby the spud may be raised or lowered relative to the guide and it is adapted to be pivotally shifted in an inward or outward direction relative thereto, a spud foot loosely connected to the outer portion of said spud, a hoisting cable, and a pulling down cable, said cables being attached to the spud adjacent to the pivotal and slidable connection between the spud and the guide. Seventeen claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

12,088/1913. "IMPROVEMENTS IN GRAPPLING DEVICES FOR USE IN CONNECTION WITH THE RAISING OF SUNKEN VESSELS." L. VALEROY, OF BIBERIST.

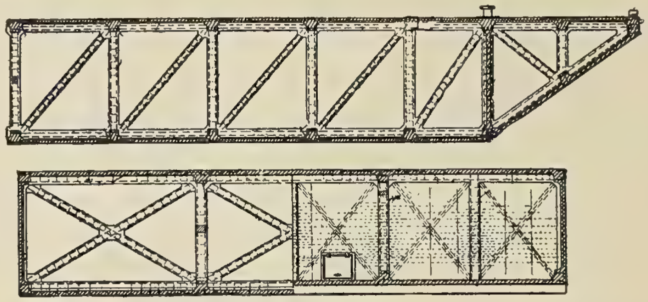
Relates to grappling devices for use in connection with the raising of vessels by the method in which a float released from the sunken vessel raises a rope, down which a lifting chain or the like, having a grappling device, is slid from a salvage vessel, which grappling device automatically couples itself to a union cone secured to the sunken vessel. In the drawing the grappling irons are shown being lowered down the guide rope; the ring guiding the irons onto the cone, which is secured to the vessel to be raised.

24,934/1913. NEW OR IMPROVED MEANS FOR TRANSFERRING LIQUIDS TO OR FROM SHIPS OR VESSELS. T. FAIRFIELD, OF 20 GLOUCESTER CRESCENT, LONDON.

Any desired length of ordinary or armored hose has a number of ropes of steel or other suitable material arranged in a longitudinal direction around its periphery, the size and strength of such ropes being varied according to the towing or pulling strain which they are intended to bear. A rope is connected to and bound round ropes for the purpose of keeping the latter in position on the hose and also for resisting the interior pressure on the hose when the liquid is being pumped through. The ropes are connected at each of their ends to a coupling device consisting of a tube of metal provided with a flanged end, these ends are passed through holes in the tube and then spliced. A tube with a flanged end passes through coupling and extends for a certain distance into hose. To allow for any stretching of ropes and consequent movement of hose and tube, the latter projects beyond the flange of the coupling device.

19,077/1913. IMPROVEMENTS IN THE CONSTRUCTION OF BARGES, SCOWS, PONTOONS OR OTHER VESSELS OF REINFORCED CONCRETE. N. K. FOUGNER, MANILA, PHILIPPINE ISLANDS.

Claim.—The invention relates to improvements in the construction of barges, scows, pontoons or other vessels of reinforced concrete, and,



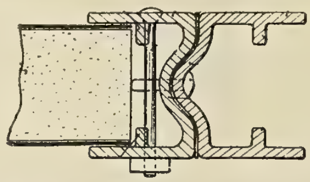
more particularly to the method of construction employed in specifications Nos. 29,938 and 29,939 of 1912. It is not intended to lay claim to any special type of steel reinforcement, but the essence of the invention is the scientifically designed arrangement of the steel in the various parts and portions of the vessels, and the shape and arrangement of the different detail members of the craft. The drawing indicates a part vertical transverse section and a part vertical longitudinal section of a scow.

14,192/1913. NAUTICAL INSTRUMENT. KELVIN & JAMES WHITE, LTD., OF 16, 18 AND 20 CAMBRIDGE STREET, GLASGOW, AND M. B. FIELD.

An instrument primarily for use in locating the position of a ship at any time relatively to a chart. It consists of a transparent sheet so adapted that when superimposed upon an ordinary chart the chart may be easily read through the instrument. Marked on the sheet is a graduated circle. From the center of the circle are drawn two lines perpendicular to one another. Parallel to one of these lines is drawn a series of lines uniformly spaced apart. These parallel lines are intersected by lines drawn from the center of the circle and inclined to the parallel lines at angles corresponding to the angular displacement from the lubber line of the markings on the compass bowl. The points of intersection of one of the parallel lines with the inclined lines may thus be taken to represent stations uniformly spaced apart. The navigator, taking the bearings of an object from stations on the course line, the observation angles of which are represented by two angles of the series above referred to, and measuring by means of the log the distance between the two stations, can estimate the distance at which the ship will pass the object sighted.

11,987/1913. PORTABLE WALL SECTION PARTICULARLY APPLICABLE FOR USE IN THE CONSTRUCTION OF SHIP BULKHEADS. H. PLOGER AND ANOTHER, BERLIN, GERMANY.

Relates to paneling for use in the manufacture of ships' bulkheads, each section embodies a rigid open frame formed of profiled metal bars, which frame forms a receiver for the material, which may have both fire and sound-resisting qualities. The outline of the lateral frame end bars



are of the shape shown or of any similar shape, comprising a projection and a depression so that the faces of two adjoining end bars will interengage in the manner shown. The adjoining end bars are connected by means of flat iron pieces and are retained externally by means of bolts.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of International Marine Engineering, published monthly at New York, N. Y., required by the Act of August 24, 1912.

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ALDRICH PUBLISHING CO.,
H. L. Aldrich, President and Treasurer.

Sworn to and subscribed before me this 14th day of September, 1914.

Oscar M. Pickruhl.

(My commission expires March 30, 1915.)

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Marine Engineers' Prize Contest

As announced in our last issue, cash prizes of $15, $10 and $5 are offered by this journal for the three best letters sent by marine engineers to our Contest Editor before January 1, 1915, telling about their experiences in the engine room. As only a month remains before this contest closes, readers should forward their letters without delay. Any subject relating to the construction, installation or operation of marine machinery may be chosen, including breakdowns and repairs, and any engineer may send as many letters as he chooses. Each letter that is awarded a prize will be paid for at the time of publication at regular space rates, in addition to the prize. Also any other letters that fail to receive a prize, but which are considered worthy of publication, will be published in later issues of the magazine and paid for at regular space rates.

Notable Addition to the American Coastwise Fleet

Within a few months the Spokane, Portland and Seattle Railway Company will place in service between Astoria, Ore., and San Francisco, Cal., two splendidly equipped 23-knot, triple-screw, turbine-driven passenger and freight ships that are now nearing completion at the yards of the William Cramp & Sons Ship and Engine Building Company, in Philadelphia. This steamship line will complete a direct route from the East to San Francisco over the Great Northern Railway lines, and as the passage by boat from Astoria to San Francisco will be made in from 25 to 26 hours, the schedule along the coast by water will be equivalent to the overland journey by rail. As can be seen from the description of these vessels, published elsewhere in this issue, the new steamships will be of the finest type that the modern art of shipbuilding can produce. Every convenience and luxury known to ocean travelers compatible with the paramount requisite of safety and reliability in navigation has been incorporated in their design. Propulsion is by a three-shaft arrangement of Parsons turbines supplied with steam by oil-fired watertube boilers. Extensive use of electricity, both for lighting and for power purposes, has been made, and the important problems of heating and ventilation and the rapid handling of freight have been worked out with exceptional care. The creation of this noteworthy addition to the American coastwise fleet reflects great credit on the owners and builders of the vessels, not only from an engineering standpoint, but also as a step in advance in the complex problem of transportation. The trials and service runs of the *Great Northern* and *Northern Pacific* will be watched with interest.

Isherwood Framed Tank Ships

Extensive as the application of the Isherwood system of longitudinal framing has been to various types of vessels—two hundred and twenty-six such vessels, aggregating 1,182,200 gross tons, were classed by Lloyds up to June 30, 1914—this form of construction has found special favor, both from the designer's and from the owner's point of view, in oil tank ships. The principal advantage from the designer's standpoint is the fact that the required strength of the ship can be obtained with a great saving in weight over the ordinary system of transverse framing, while from the owner's point of view the saving in weight means added earning capacity for the ship. It is pointed out, however, in an article on Tank Ship Construction, printed on another page of this issue, that the opinion seems to be prevalent among shipowners that the Isherwood framed ship requires more frequent repairs and is shorter lived. If this condition is real and is not the outgrowth of prejudice among shipowners, it by no means presents an obstacle that cannot be overcome as further experience is gained. What is of more importance, however, is the difficulty encountered by shipbuilders in the actual work of constructing the hull. Every part of the ship must be completed at a definite time and worked into the structure at a certain period of construction, otherwise the entire work will be delayed and the cost of construction will rapidly mount up. It is in points like this that experience counts, and readers who are unfamiliar with the actual procedure in the erection of an Isherwood framed ship will do well to study carefully the article dealing with this subject.

Bids for New Destroyers

When the bids for the six new destroyers authorized by the last Congress were opened on November 10 at the Navy Department it was found that an estimate submitted by the Mare Island Navy Yard, California, was about $200,000 (£41,000) less for each destroyer than the bids submitted by private shipbuilding firms. If this estimate could be considered as a strictly competitive bid, it would, of course,

be most attractive, but past experience with naval construction in Government navy yards has given ample proof that it is practically impossible for a navy yard to build a warship as cheaply as a private shipyard can build it, and, furthermore, the cost of repairs on Government-built vessels invariably amounts to a larger sum than the cost of repairs to a contract-built ship. It should not be forgotten that a number of private shipbuilding firms, such as Wolff & Zwicker, of Portland, Oregon; the Charles Hillman, Trigg and other companies failed and went out of business years ago in their efforts to build far less complicated destroyers than the vessels authorized to-day at approximately the same price per ton as the Mare Island Navy Yard offers to build the new destroyers, while several other private concerns were seriously crippled financially in their attempts to meet Government prices. It is physically impossible for a Government yard which must depend upon employees inexperienced in construction work to turn out a naval vessel of the type of the new destroyers at about $200,000 (£41,000) less than it is possible for a private shipyard with its years of experience and its skilled organization, trained in this particular kind of work, to do the same work. Moreover, when a Government yard fails to complete the construction of a vessel within the appropriation made for it, it is possible to get additional appropriations from Congress to cover the extra expense; while if such a loss occurs in a private contract, the contractor must suffer the loss.

Lloyd's Annual Report

For the year ended June 30, 1914, 713 new vessels of 2,020,185 gross tons were classed by Lloyd's Register of Shipping, and these figures represent the highest total for any one year recorded in the history of the society. Of the total, about 60 percent were built for the British Empire and about 40 percent for other countries. The total number of merchant vessels classed by Lloyd's up to June 30 was 10,621, registering nearly 24,000,000 gross tons. In commenting on the year's activity in shipbuilding, the Annual Report of Lloyd's Register, just issued, calls attention to many features which are of special interest to the shipbuilder.

Chief among these features is the rapidly increasing use of steam turbines, and especially the application of geared turbines. At present there are 23 vessels being built to Lloyd's classification in which geared turbines are to be fitted. The introduction of geared turbines has enabled a high peripheral speed to be obtained by using comparatively small rotor drums running at very high rates of revolution geared with the screw shaft running at the lower rate of revolutions which would be used with reciprocating engines of the same power, thus combining the high efficiencies of steam turbines and of slow-running propellers. At the same time, six merchant vessels are now under construction to Lloyd's Classification in which direct turbine drive will be used, and also six vessels in which the three-shaft arrangement of combination machinery will be installed. An advantage of the three-shaft combination machinery, in which the outer shafts are driven by reciprocating engines and the center shaft by a low-pressure turbine, is that the machinery can be worked at reduced power with practically the same efficiency as at full power. The speed of these engines is reduced by "linking up," enabling the full steam pressure to be utilized in the cylinders, whereas with ordinary steam turbines the speed can be regulated only by varying the steam pressure so that when less than full power is required the steam pressure has to be reduced and a corresponding loss of efficiency results.

Another feature to which attention is directed in the report is the increasing number of large Diesel-engined motor ships, there being at the present time 27 vessels holding Lloyd's Classification which are fitted with Diesel engines, aggregating approximately 50,000 indicated horsepower, and 20 others of the same type now building. One of the principal Diesel motor ship owners is the East Asiatic Company, whose earliest vessel of this type, the *Selandia,* has two 8-cylinder engines with cylinders 20⅞ inches diameter by 28¾ inches stroke, aggregating 2,500 indicated horsepower. The latest vessel owned by this company is the *Fionia,* in which two 6-cylinder engines with cylinders 29⅛ inches diameter by 43 5/16 inches stroke, aggregating 4,000 horsepower, are installed. These are the largest cylinders which, as yet, have been used for Diesel engines in merchant ships.

During the last year 19 vessels, each of over 10,000 gross tons, have been classed by Lloyd's, the largest being the Curnard liner *Aquitania,* of 45,649 gross tons. At the present time no less than 15 steamships of 12,000 tons and over are under construction under Lloyd's Classification, while the special types of vessels classed by Lloyd's during the year included 72 oil tankers of 402,033 tons, 5 of which were over 10,000 gross tons each, and 72 vessels of 429,384 tons, built on the Isherwood system of longitudinal framing. This brings the number of vessels of this type built under Lloyd's Survey up to 226, totaling 1,182,200 tons gross.

While Lloyd's rules provide for the construction of vessels conforming to a standard of strength entitling them to the highest class, the technical committee of the society is always prepared to approve of proposals involving variations from the methods of construction specified in the rules, provided equivalent structural strength is maintained. The committee is also prepared to assign classes to vessels intended for special purposes so long as the scantlings and arrangements proposed render the vessels efficient for the employment contemplated. Special types of vessels assigned classes in this way during the last year included the steamers *Atlantic* and *Pacific,* built by the Fore River Shipbuilding Corporation, Quincy, Mass., which are the largest lumber steamers flying the American flag; two vessels for the Russian Government and one for Australia intended to carry oil in bulk and especially strengthened for the purpose of supplying warships with fuel oil at sea; and an auxiliary schooner yacht being

built by Lawley & Sons, Boston, Mass., in the construction of which alloy steels of high tensile strength are used in order to reduce the scantlings and at the same time meet Lloyd's requirements for structural strength.

Important changes in Lloyd's staff during the past year, some of which have already been noted in these columns, included the appointment of Prof. W. S. Abell, professor of naval architecture at the University of Liverpool, to the office of chief ship surveyor, filling the vacancy caused by the death of Dr. S. J. P. Thearle; the promotion of Mr. Charles Buchanan, formerly assistant to the chief ship surveyor, to the position of principal of the chief ship surveyor's staff, which he was forced to resign in September on account of ill health; and the appointment of Mr. James French, formerly on special duty in the United States, to the post of principal surveyor at Glasgow, succeeding Mr. T. J. Dodd, retired. A number of additional surveyors were also appointed in foreign ports, so that there are now 89 Lloyd's surveyors stationed in various ports outside Great Britain.

American Society of Naval Architects

Organized in 1893 to promote practical and scientific knowledge in the arts of shipbuilding and marine engineering, the Society of Naval Architects and Marine Engineers has held regularly at least once each year, and sometimes oftener, meetings for social intercourse and for the reading and discussion of professional papers. The information thus brought out has been made available to the members by the publication of the transactions of the Society. The membership is divided into classes designated as members, associates, juniors, honorary members and honorary associates. The number of honorary members and honorary associates is limited, and the honor of holding this membership is conferred by the Council. Eligibility for membership in the other grades depends upon the experience of the applicant in the practice of the profession of naval architecture and marine engineering or his association with allied industries. The entrance fees and annual dues are nominal and insignificant in comparison with the value of the transactions of the society, which are circulated among all the members. It is desirable for every naval architect and marine engineer to become a member of this society, on account of the opportunity offered to become more intimately acquainted with the leaders in the profession and also to learn much valuable knowledge from the extensive experience of others in the same branch of engineering. Considering the fact that a member of any grade has full access to the complete proceedings of the society, naval architects and marine engineers in foreign countries will find it a distinct advantage to become enrolled in the society, and it is to be hoped that as the society continues to grow its membership will include a greater number of men allied with the shipbuilding industry in every part of the world.

Some indications of the recent tremendous strides in the art of shipbuilding are shown by comparison with the views brought out at the first meeting of the society over twenty years ago regarding the evolution of the Atlantic "greyhound." In a paper on this subject by Mr. Charles H. Cramp it was stated that the limit of commercial practicability in the size and speed of the transatlantic steamship had been reached in the Cunard liner *Campania*. At that time the limit of draft in the principal harbors was about 28 feet, and, while it was hoped that before long, by dredging away bars and deepening docks, it might become practical to design a ship on dimensions permissible with a draft of 30 feet, which would mean a ship about 700 feet long and 75 to 80 feet beam, it was not considered worth while, however, to consider such a contingency! In the interval between that first meeting and the present time tremendous strides in the evolution of the modern transatlantic liner have taken place, and various phases of the problems encountered in this remarkable evolution are discussed in the successive volumes of the Society's transactions, forming a library of inestimable value with which every naval architect and marine engineer should be familiar.

Electric Propulsion

It is seldom that a new system of ship propulsion has vindicated the claims of its designers more completely at the start than was the case with the electric drive installed on the United States collier *Jupiter*. This ship has been in commission for over a year and a half; she has steamed about 14,000 miles, and has been placed through every conceivable maneuver under all conditions of service. The economy which she has shown is from 20 to 25 percent better than her sister ships, and, so far, no troubles of a serious nature have developed and the performance has been satisfactory in every respect. As a result the Navy Department has decided to install electric drive on the battleship *California*, to be built at the New York Navy Yard. The *Jupiter* was designed for a speed of 14 knots, and, on a draft of 27 feet 9 inches, displaces 19,452 tons. The propelling machinery consists of a 9-stage Curtis turbine connected to a 2-pole 3-phase AC generator and two 36-pole 3-phase induction motors. The turbine operates at 1,990 revolutions per minute and the motors at 110 revolutions per minute. On her 48-hour full-speed trial, the vessel attained a speed of 14.99 knots, the propellers turning at 116.72 revolutions per minute and the motors developing a shaft horsepower of 7,151.9. The water rate per shaft horsepower was 11.68 pounds, which is 10.15 percent better than the guarantee of 13 pounds. On her 24-hour trial at 10 knots, the water rate per shaft horsepower was 12.316 pounds, or 18 percent better than the guarantee of 15 pounds. The coal consumption per shaft horsepower at full speed was 1.662 pounds and at 10 knots speed 2.51 pounds. Some of the special advantages pointed out by the officers in charge of the *Jupiter* are the fact that the vessel can make her contract speed without using forced draft, that the machinery is very handy for maneuvering, and that there is a total absence of racing at sea on account of the action of the governor.

Tank Ship Construction

Features of Construction as Applied Especially to Isherwood Framed Oil Tankers

BY ROBERT WHITING MORRELL, M. E.

The tank ship for carrying oil in bulk is undoubtedly the most highly specialized type of merchant vessel. It embodies a combination of features entirely unique and distinctive. Much has already been written on the subject of tank-ship design from the naval architect's standpoint. We can, therefore, pass over the questions of dimensions, coefficients, form, speed, strength and scantlings, to a consideration of the special features of construction which are peculiarly adapted to this type of vessel from the standpoint of the yard superintendent, the surveyor, and the owner.

It may be of interest to note in passing that when the length between perpendiculars exceeds twelve and one-half times the depth, recent experience has indicated the advisability of a slight increase in longitudinal strength beyond that required by the scantling rules. In this connection there is a splendid opportunity for obtaining useful data by means of a micrometer attachment on the ship's deck. Observations made on a large tank ship in March, 1914, in the light and loaded conditions showed about 4 inches sag when loaded.

The question of whether the ship should be of the shelter-deck type or of the forecastle, bridge and poop-deck type is an important one. The shelter-deck type has the advantage of providing greater freeboard and greater strength, thus increasing the cargo-carrying capacity. It also permits the steam and exhaust piping to deck machinery and pumps, the smothering pipes, heater pipes, etc., to be carried below deck, where they are better protected. It makes a drier ship, and provides unexposed means of access all fore-and-aft, and affords better support for the masts. Furthermore, part of the 'tween deck space can often be used to carry fuel.

On the other hand, the shelter-deck type is more expensive construction and increases the registered tonnage and certain fees. The selection of the type can, therefore, only be determined by the particular needs of the vessel in question.

In considering the question of framing, namely, the Isherwood, or longitudinal system vs. the ordinary transverse system, there are several points involved.

From the designer's standpoint the Isherwood system is pre-eminently suited to the tank ship. The designer must deal not only with the strength of the ship as a whole, but with excessive local stresses due to the pressure of oil. With the Isherwood system the framing, the deck beams and the stiffeners on the longitudinal bulkheads run fore-and-aft instead of vertically or transversely; and thus the members designed to withstand the local stresses also incorporate themselves into the longitudinal strength of the ship as a whole. In this way the designer is enabled to obtain the required strength with a great saving in weight over that required by the old transverse system.

From the standpoint of the yard superintendent the Isherwood system is a great bugbear. In the mold loft the unequal spacing of the transverse or belt frames throughout the ship makes shell and frame development and the use of universal molds exceedingly complicated. The longitudinal frames, usually long lengths of heavy bulb or channel section, are very unwieldy and difficult to handle and work in the shops. The work in the ship is particularly difficult to fair up and pull into place. The worst feature, however, is the order of assembling work in the ship. Each particular member must be put in its place at a certain definite period in construction, else it cannot be gotten in. If one piece of material is overlooked, the ship has to be torn apart to get it in; or if any particular parts are not ready when the ship is ready for them, the entire work comes to a standstill until they are obtained. These disadvantages of the Isherwood system make it very costly and unpopular from the yard's standpoint.

From the owner's point of view the Isherwood system, in effecting a saving in weight of structural material, affords an increase in the earning capacity of the ship. To offset this, however, are recent reports from those operating tank ships of the Isherwood type, that there is a marked deflection and lack of rigidity in the ship as a whole; in other words, the ship "works." This, however, might result as readily in a ship of the same dimensions with transverse framing of equivalent strength. One point against the Isherwood system is that, in case it becomes necessary to renew any structural members, the repair bill is very large, on account of the difficulty in getting the various parts out or in. The opinion also seems prevalent among shipowners that the Isherwood ships require more frequent repairs and are shorter lived; they claim that, due to the large area between transverses, supported only by light longitudinals, the ship becomes dented very easily in docking or otherwise.

It has become almost a fixed rule to locate the propelling machinery at the extreme stern in a tank ship. The reasons for this are: First, that with the machinery amidships it would cause an abrupt discontinuity in the structural design, greatly affecting the strength; also, when loaded, the weight is in the ends, putting a severe hogging strain on the ship; second, it would require a cofferdam bulkhead forward and aft of the machinery and bunker space, to isolate it from the oil space, involving additional weight and cost; third, it would require an oil-tight shaft alley through the after oil space, which would be a heavy and expensive proposition.

Practice varies regarding the location of the pump room. Usually it is located amidships, between two oil tanks, which makes a good, central location. One disadvantage of this is that, if there is any leak in the oil-tight bulkheads, the pump space becomes dangerous, and cofferdam bulkheads are not warranted. The pump room, located amidships, also causes a break in the continuity of the strength members, due to openings in the centerline bulkhead and the deck in this space. It is necessary to compensate for the decrease in strength. The opening in the deck should have round corners, as square corners afford a point of weakness at which the deck plating will crack. Some are in favor of placing the oil pumps back in the machinery space, to do away with the long lead of steam piping. The objection to this is that it extends the machinery space forward, which is undesirable, as the ship will trim by the head when loaded with bunkers empty, unless the oil space is kept as far aft as possible. Another solution is to place the pump room directly forward of the oil space. The only objection to this is the long length of pipe lines, which is not so important when it is considered that in many places steam from the shore is used on the pumps.

When running light it is necessary to carry water ballast forward to balance the weight of the machinery aft. For this purpose the forepeak tank is fitted for water ballast, and a deep tank is provided in the space forward of the oil space. In addition to this water is generally carried in some of the main oil tanks to bring the ship down to a suitable draft, and to prevent hogging. The afterpeak tank is also fitted for water ballast, which is necessary to carry aft if the ship has a tendency to trim by the head when loaded. Double bottoms are usually fitted under the machinery space, in which water ballast, reserve feed, or fuel oil may be carried.

If coal is burned, side bunkers should be used in the boiler space if possible. If this is impossible or insufficient, a cross bunker, kept as far aft as possible, is provided. If the ship is of the shelter-deck type the coal may be carried in the 'tween decks, with chutes to the fire room. It is possible to extend the poop deck forward to provide a similar bunker.

With fuel oil the double bottoms under the machinery space are used as bunkers, and the forward deep tank may also be used. If necessary, a fuel oil tank just forward of the boiler room can be provided. In this case an asbestos insulation is necessary on the forward fireroom bulkhead. Filling pipes for this tank can be connected to the cargo oil system.

The cargo oil space extends as far forward and aft as the trim of the ship will permit, and terminates in cofferdams which isolate it from the rest of the ship. The oil space is divided by transverse oiltight bulkheads into a number of tanks not over 28 feet in length. An oiltight centerline bulkhead divides the ship into port and starboard tanks. In order to reduce the free surface of the oil, for the purpose of stability, an expansion trunk is provided, comprising not over half the width of the tank.

An oiltight main deck extends throughout the oil space, from the shell to the expansion trunk bulkhead. The latter is an oiltight longitudinal bulkhead extending from the main deck to the upper deck, port and starboard. The space between the centerline and this bulkhead is the expansion trunk.

The upper deck is next above the main deck and extends from shell to shell, and is oiltight thoughout. This deck forms the top of the oil space. The small wing tanks formed by the shell, the main deck, the expansion trunk bulkhead and the upper deck are known as the summer tanks, presumably for the reason that only in summer, when the oil is light, these tanks can be filled; which, however, does not always hold true.

The Isherwood framing in the oil space consists of heavy transverse or belt frames, spaced about 9 or 10 feet apart, and a series of longitudinal frames, usually of channel section on the bottom and bilge, and of bulb angles on the side shell. These are intercostal between transverse bulkheads, to which they are bracketed, and they pass through slots in the transverse frames.

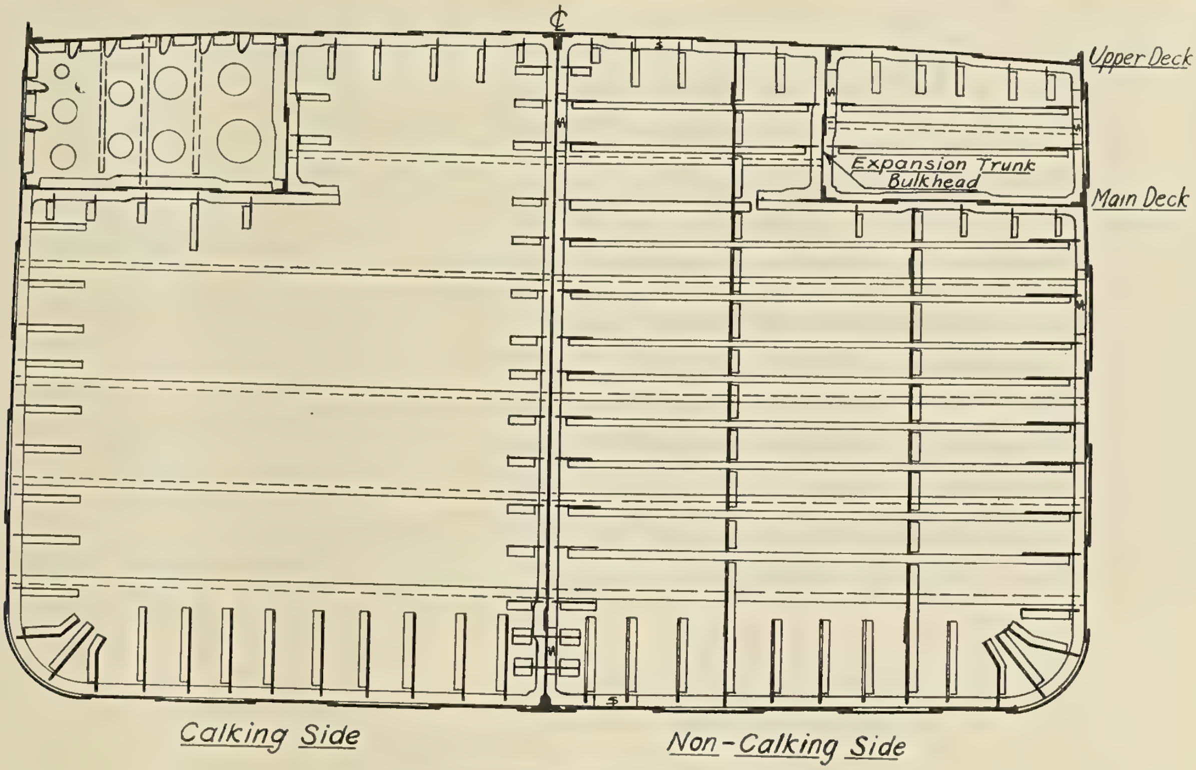

Fig. 1.—Construction of Bulkhead for an Oil Tanker

This brings us to a consideration of the various structural features which will be taken up in the order in which they are assembled in the ship.

In the mold lofts molds can be made for almost every piece of material in the oil space, and in this way the material can be gotten out in advance and is ready for assembling whenever wanted. The only exceptions are: certain outside strakes of shell plating forward and aft and one strake amidships; all of the brackets connecting the centerline bulkhead to the transverse bulkheads; certain strakes of deck plating; deck stringer angles forward and aft, and the bounding angles on the oiltight summer tank bulkheads. All these members should be lifted from the ship. The shell longitudinals have to be developed in a manner similar to the shell plating. It is important to check all molds, to make sure that the required rivet spacing and number of rivets are provided before the steel is punched.

The flat keel is oiltight throughout the oil space. The rivet spacing and calculations can be found in any book of rules, and will not be dealt with here. If inside keel buttstraps are fitted they should be cut about 1 inch clear of

the toe of the keel angles on each side. This enables the angles to continue through without linering, and the strap being cut slack provides a runway for the oil to the bleeders and gives room for calking the toe of the keel angles. The vertical keel, which forms the bottom strake of the centerline bulkhead, is shipped immediately after the flat keel. The vertical keel plating, being a strength member, must rest solidly on the flat keel. The plates should be butt-lapped, with scarfs in way of the keel angles. Both flanges of the keel angles should be countersunk. Great care should be taken in countersinking the vertical keel; for this being part of the centerline bulkhead, the rivets are driven from alternate sides in adjacent tanks, and hence the countersinking alternates. Thus in No. 1 tank the rivets will be driven from the starboard side, in No. 2 tank from the port side, and so on, aft, alternating. The side from which the rivets are driven and calked is called the calking side, and this side is countersunk. The calking side alternates in order to facilitate tank testing and also in order to equalize the weight better.

After the keel is laid the universal bottom shell, i. e., where the ship's bottom is flat, is placed in position on the spauls, and the bottom shell longitudinals or frames can also be put in place, but it is important not to bolt up any of this work until the bulkheads and transverses have been shipped. These bottom shell longitudinals are heavy 12-inch channels, or in large ships they may be built up of 15-inch plates, with top and bottom angles. If built up they are riveted on the ground before shipping, except the rivets directly in way of transverse frames, which should be omitted on the ground. In way of skin strakes of shell plating the shell longitudinals have to be offset to take the butt-laps of the shell; but in way of outside strakes the longitudinals are run straight across the butt-laps and tapered liners are used. Shell holes are omitted where the longitudinals cross the shell butt-laps. When the shell longitudinals have a decided curvature they should be offset before they are bent, as the curvature may prevent their entering the joggling machine.

The next step is to assemble on the ground and put in the ship the transverse oiltight bulkheads. These are in reality half bulkheads, being cut in the middle by the centerline bulkhead, which is continuous. The bulkheads are just the shape of the main oil tanks, but do not extend through the summer tanks, except the end cofferdam bulkheads, which are merely watertight. The bulkheads are plated with horizontal strakes, which permit a decrease in the thickness of plating toward the top as the pressure due to the head of oil decreases. Generally the plating can extend in one piece from the centerline to the shell.

The bounding angles are always double, single-riveted, countersunk in both flanges. The long shell bounding bars, extending around the turn of the bilge, are so unwieldy to handle in the shop that it is often advisable to countersink the shell flange on the skids.

Bounding bars are strapped at the butts, never lapped. This is because offsets in oiltight work are very undesirable, causing expensive anglesmith work and being very difficult to make tight, often requiring a "Dutchman" to fill in where the offset is not neat enough. For this reason shell bounding angles are not offset at the outside strakes of shell plating, but parallel liners are used.

These liners are rectangular and take one row of holes outside the toe of the bar on each side. These holes are countersunk. The liner must fit neatly against the edges of the skin shell plates, and should be in place on the bottom shell befoe the bulkheads are shipped or the shell bolted. The liners under the bulkheads on the flat keel are scarfed, if the thickness of the garboard is different from that of the keel angle. If this is the case, it is important to get these liners in ahead of the bulkheads. If the garboard or other strake is a clinker strake, a long tapered liner is used, which in this case does not extend beyond the toe of the bounding angles.

The bulkhead plating should not be joggled, but worked "in and out," with parallel liners between it and the bounding bars. The bounding angles can be riveted to the bulkhead on the skids, except the centerline bars and the staples at the corners of the bulkhead, which are left loose in case any fairing or regulating is necessary in the ship.

The clips, or "lugs," for the connection of brackets for longitudinals should be riveted to the bulkhead on the skids. These clips should be cut at least 1 inch slack from the toe of the bounding angles for calking, and should also be kept clear of the calking edges of seams of bulkhead plating, if possible. The brackets should not be put on the clips on the ground, as they would have to be taken down again to rivet the bounding bars in the ship.

The bulkheads are assembled on the skids with the calking side up, and the stiffeners will therefore be on the under side. The stiffeners run horizontally and are usually of bulb angle, heel up, and can be riveted to the bulkhead complete. The outboard end of the stiffener takes the bracket for the side shell longitudinal, which is normal to the shell, and it is often necessary to knuckle the bracket on this account. The stiffener, therefore, should end short of the toe of the longitudinal. The lowest stiffener should come well above the turn of the bilge on this account, and below this the bulkhead is stiffened by heavy vertical clips and brackets connecting to the bottom shell longitudinals.

(To be concluded)

Programme for Naval Architects' Annual Meeting

The final list of papers for the twenty-second annual meeting of the Society of Naval Architects and Marine Engineers, to be held at 29 West Thirty-ninth street, New York, on December 10 and 11, is as follows:

THURSDAY, DECEMBER 10

1. "International Conference on Safety at Sea." By Hon. E. T. Chamberlain.

2. "Safety of Life at Sea. Application of Subdivision Rules Adopted at International Conference." By Mr. James Donald.

3. "Safety of Life from Fire at Sea." By Mr. W. O. Teague.

4. "Launching Data for a Battleship." By Naval Constructor J. G. Tawresey, U. S. N.

5. "Stability of Vessels as Affected by Damage Due to Collision." By Mr. William Gatewood.

6. "Expansion or Contraction of Certain Dimensions and the Effect upon Resistance." By Professor H. C. Sadler.

7. "Some Experiments with Models Having Radical Variations of After Sections." By Naval Constructor D. W. Taylor, U. S. N.

FRIDAY, DECEMBER 11

8. "Recent Developments in Submarine Signaling." By Mr. J. B. Millet.

9. "The Thermodynamics of the Marine Oil Engine." By Mr. John F. Wentworth.

10. "Refueling of Warships at Sea." By Mr. Spencer Miller.

11. "Our First Frigates. Some Unpublished Facts About Their Construction." By Hon. F. D. Roosevelt, Assistant Secretary of the Navy.

12. "The Behavior of Riveted Joints under Stresses." Mr. James E. Howard.

14. "The Application of Electric Propulsion to Battleships, together With the Experience Gained in the *Jupiter*." By Lieutenant S. M. Robinson, U. S. N.

15. "Submarine Signalling and a Proposed Method of Safe Navigation in Fog." By Commander F. L. Sawyer, U. S. N.

S. S. Great Northern and Northern Pacific

New 23-Knot Turbine Passenger Ships Built at Cramp's for the Spokane, Portland & Seattle Railway Company

Two of the finest ocean-going express steamships ever built in the United States are the *Great Northern* and *Northern Pacific,* now nearing completion at the yards of the William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa. These vessels have been constructed to the order of the Spokane, Portland & Seattle Railway Company for service on the Pacific coast between Astoria, Ore., and San Francisco, Cal. Designed for a speed of 23 knots with a capacity for 856 passengers and 2,185 tons of freight, they will, under favorable conditions, make the passage from Astoria to San Francisco in from 25 to 26 hours, equaling the time now required for traveling by the overland route from Portland, Ore., to San Francisco, and thus establishing a direct route from the East to San Francisco over the Great Northern railway lines.

The Astoria terminal of the line is situated at a point about four miles from Astoria down the Columbia River, where the Spokane, Portland & Seattle Railway Company is building a new pier 600 feet long on which is a single story shed 80 feet wide. The railway tracks run directly on to the pier, and adjacent to the pier is ample space for a freight and storage yard. The maximum fall of tide at this point is 9 feet, and as the new ships will be loaded mainly through side ports, inclined elevators will be provided for the rapid handling of freight between the ships and the pier. At San Francisco, where the fall of tide is 6 feet, one of the State-owned piers has been leased, and this also will be provided with similar facilities for the rapid handling of freight.

To meet the exacting requirements of this service, which calls for high speed, safety, reliability, and at the same time luxurious appointments, the new vessels have been designed on lines closely resembling those of a finely modeled steam yacht. Speed, strength and seaworthiness are apparent to the experienced eye at a glance. The graceful lines of the hull, the ample freeboard and well protected decks are thoroughly in keeping with the characteristics commonly associated with an ocean greyhound, and a careful study of the details of the vessels will show that in the design of both hull and machinery no effort has been spared to make the new flyers among the finest specimens of their type ever turned out from an American shipyard.

Fig. 1.—Steamship *Great Northern* Fitting Out at Cramp's Shipyard

Classed A 100 in accordance with the rules of the British Lloyds, the *Great Northern* and *Northern Pacific* are also equipped to pass the laws now in force by the United States Steamboat Inspection Service. This inspection was required by the builders, and is to be made at their yard before the vessels are delivered. The contract for their construction was signed April 26, 1913, the keel of the *Great Northern* was laid September 22, 1913, and that of the *Northern Pacific* September 23, 1913. The *Great Northern* was launched July 7, 1914, and the *Northern Pacific* on October 17, 1914. The first vessel will be given her official trials early in December and will leave for the Pacific coast about the middle of January. The second vessel will follow shortly afterwards and their regular service between Astoria and San Francisco will be begun in March. The construction of the vessels was carried out under the supervision of Mr. C. C. Lacey, marine superintendent of the Great Northern Steamship Company, while their design was worked out in accordance with suggestions from the representatives of the owners by the staff at the Cramp shipyard under the direction of Mr. W. A. Dobson, naval architect, and Mr. J. F. Metten, chief engineer.

The main particulars of the vessels are as follows: Length overall, 524 feet; length between perpendiculars, 500 feet; beam, 63 feet; depth, molded to A deck, 50 feet 8 inches; draft, full load, 21 feet; deadweight carrying capacity, 2,185 tons; cubic cargo capacity, approximately 200,000 cubic feet; shaft horsepower, 25,000; speed, 23 knots; passengers, first class 550, second class 108, third class 198; total passengers, 856; crew, 198; total on board, 1,054; gross tonnage, 8,255.

The *Great Northern* and *Northern Pacific* are the largest turbine-driven passenger ships so far constructed in the

United States. To obtain the necessary power for a speed of 23 knots on the limits of space and weight available for the propelling machinery, Parsons turbines arranged on three shafts supplied with steam from twelve specially designed Babcock & Wilcox oil-fired watertube boilers were adopted. The contract specifies, however, that the ships shall maintain their designed speed of 23 knots when using steam from only ten of the boilers, the other two standing by as spares.

arriving at the northern terminal of the line with a full cargo, including passengers and baggage, and with about half of the fuel oil, half of the reserve feed water and all the stores, provisions, etc., consumed. The inner bottom, shaft alley and fuel oil tanks are considered bilged with the compartments of which they form a part. The following percentages have been deducted from the molded volume of the various compartments to allow for the water excluding portion of their contents:

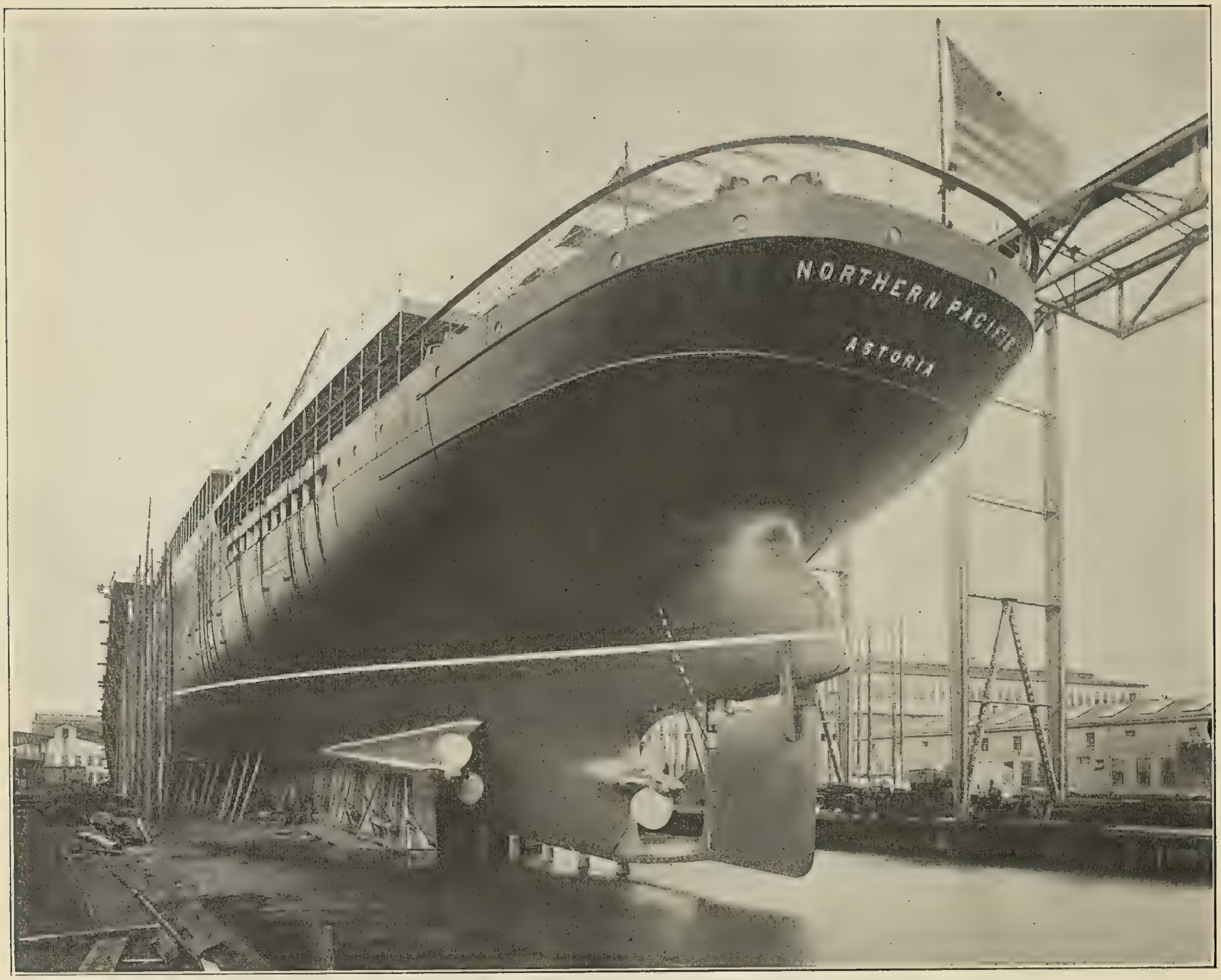

Fig. 2.—Stern View of the *Northern Pacific* Before Launching on October 17

In addition to a cellular double bottom extending throughout the length of the vessel, each ship is subdivided into eleven watertight compartments by ten transverse watertight bulkheads, all of which, with the exception of those in way of the first class dining-room amidships, extend up to the second deck above the load waterline, or a distance of fully fourteen feet above the load waterline. Abreast of the boilers extending through two of the largest compartments amidships are longitudinal bulkheads, forming wing tanks for carrying fuel oil. How effectively this subdivision of the hull protects the vessel from foundering in case of flooding either the first three or any two other adjacent compartments in the ship from a collision or other accident is shown by the diagrams in Fig. 7.

These diagrams have been developed for the ship in a mean loaded condition—that is, at 20 feet 6 inches molded draft, corresponding approximately to that of the ship

	Percent
Compartment No. 1	3
Compartments Nos. 2, 3, 4, 9 and 10	30
Compartments Nos. 5, 6, 7 and 8	5
Compartment No. 11	4

With the vessel intact the metacentric height equals 25 inches. The stability in damaged condition as shown in the diagrams in Fig. 7 is given in the following table:

Compartments 1 and 2 bilged	M-G = + 31 inches
Compartments 1, 2 and 3 bilged	M-G = + 30 inches
Compartments 3 and 4 bilged	M-G = + 30 inches
Compartments 4 and 5 bilged	M-G = + 1 inch
Compartments 5 and 6 bilged	M-G = + 25 inches
Compartments 6 and 7 bilged	M-G = — 12 inches
Compartments 7 and 8 bilged	M-G = + 15 inches
Compartments 8 and 9 bilged	M-G = + 17 inches
Compartments 9 and 10 bilged	M-G = + 11 inches
Compartments 10 and 11 bilged	M-G = + 11 inches

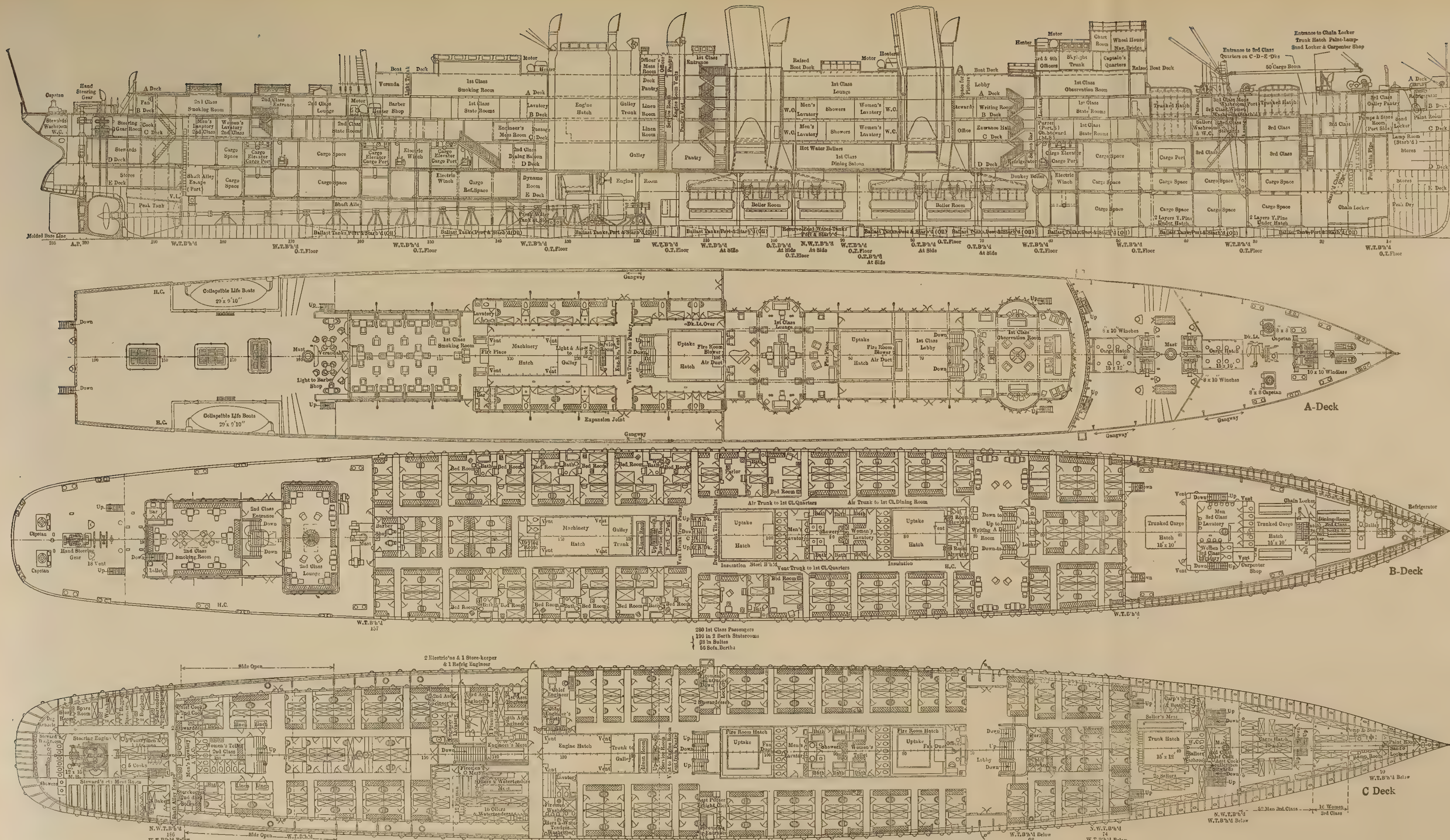

Fig. 3.—Profile and Deck Plans of the Steamships *Great Northern* and *Northern Pacific*, Built by William Cramp & Sons Ship and Engine Building Company for the Spokane, Portland and Seattle Railroad

PLATE I

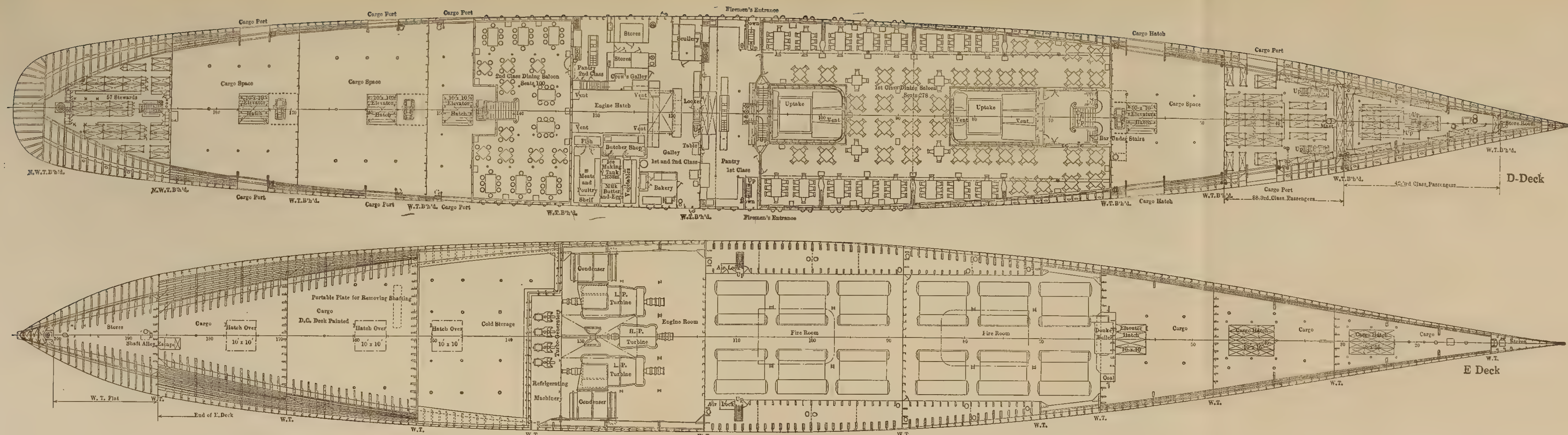

Fig. 4.—Plans of D and E Decks

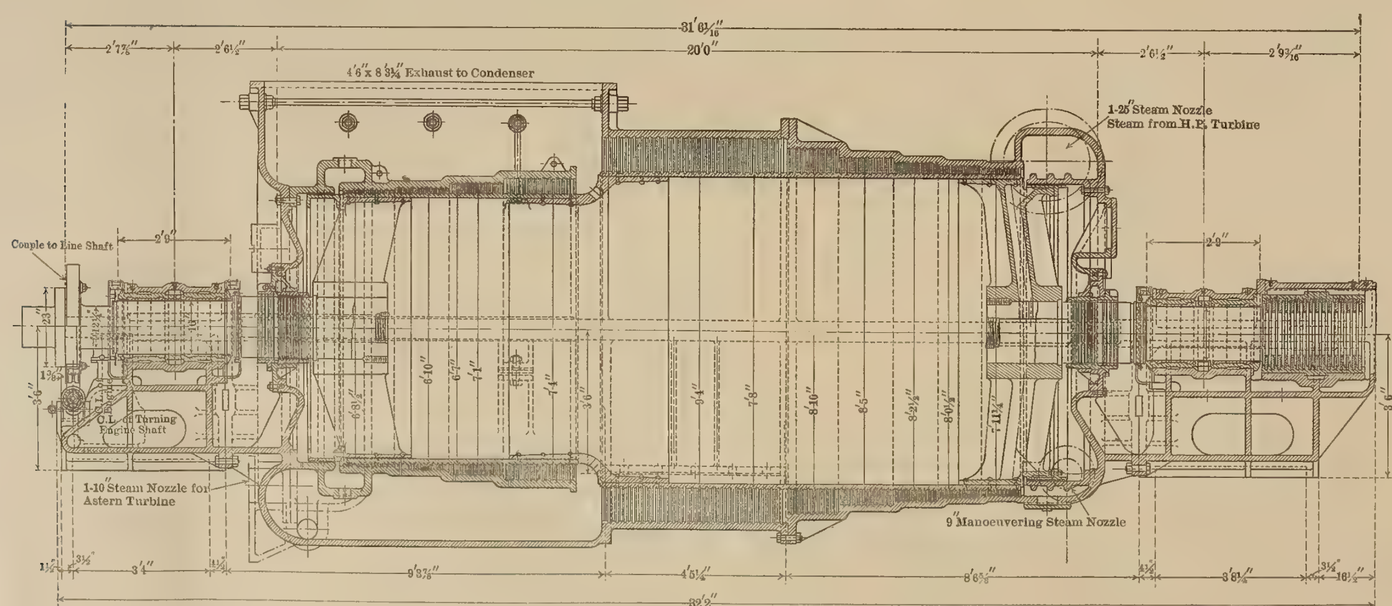

Fig. 5.—Longitudinal Section of Low-Pressure and Astern Turbine

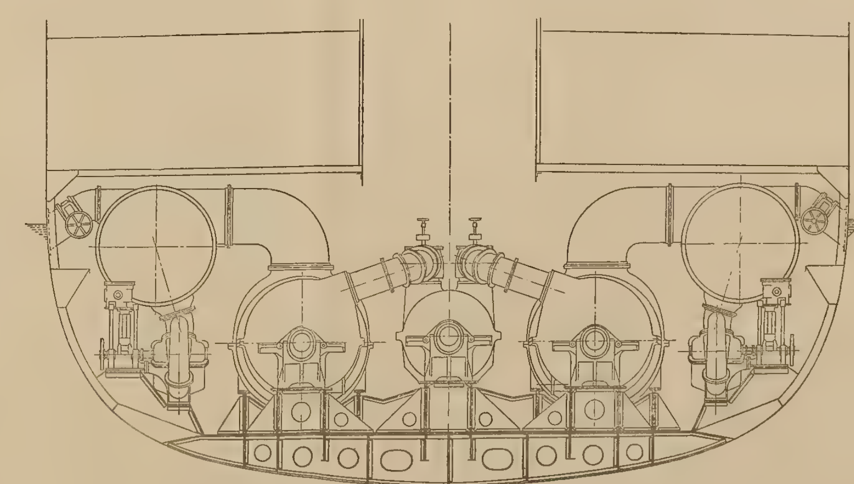

Fig. 6.—Section Through Engine Room

Steamships *Great Northern* and *Northern Pacific*, Built by William Cramp & Sons Ship and Engine Building Company for the Spokane, Portland and Seattle Railroad

PLATE II

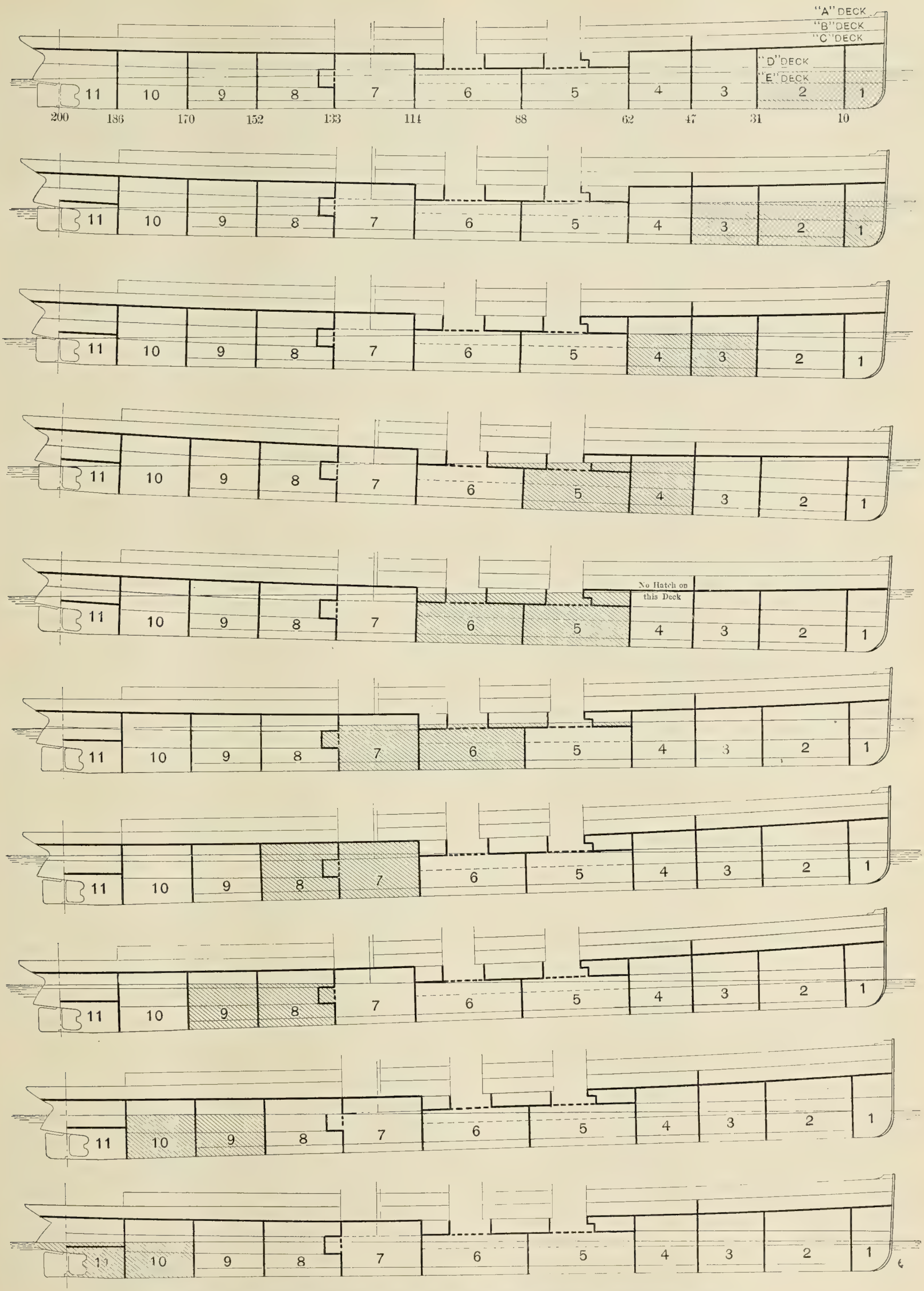

Fig. 7.—Diagrams, Showing Trim With Any Two Adjacent Compartments Flooded

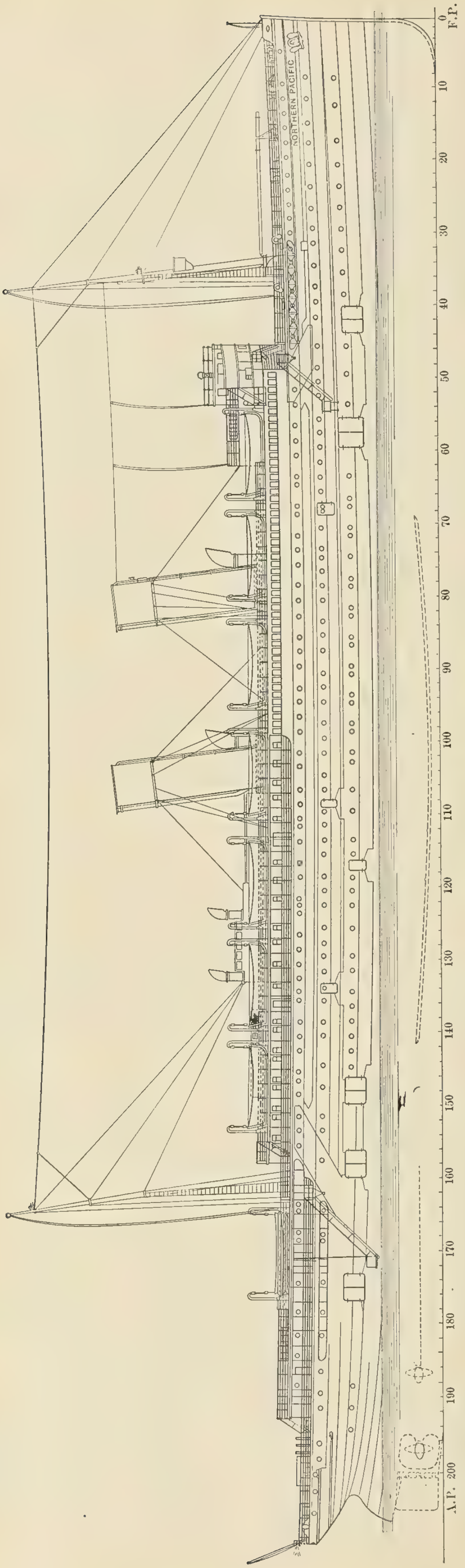

Fig. 8.—Outboard Profile of the *Northern Pacific*

In the ten watertight bulkheads there are no doors below D deck (the first deck above the load waterline) except to the shaft alley and firerooms. Above D deck, where necessary, the bulkheads are fitted with horizontal watertight hydraulically operated doors of the Stone Lloyd type. The doors to the shaft alleys are operated from the working platform in the engine room. Partial watertight bulkheads are fitted in the deep oil tanks alongside the boilers and between the forward boiler room bulkhead and the after engine room bulkhead the D deck is a watertight flat. The longitudinal bulkheads in the boiler rooms are made oiltight up to E deck, and from E deck to D deck they are watertight.

General Arrangement

In profile the vessels have straight stems, slightly raking forward, and semi-elliptical sterns. At the waterline the stern is extended aft to provide for a greater length of load line. The cellular double bottom four feet deep extending fore and aft is available for carrying fuel oil or water ballast.

Above the tank top there are six decks, designated from the top down respectively as the boat deck, A (promenade) deck, B (bridge) deck, C (shelter) deck, D (upper) deck and E (second) deck. On the boat deck are the officers' quarters with the pilot house and chart room above, the wireless station and the lifesaving equipment. Amidships on A, B, C and D decks are the first class accommodations. The A deck, which is a flush deck from the stem to the end of the deck house near the stern, is given over to public rooms with the exception of a limited number of single berth staterooms which are reserved for bachelor quarters. The first class staterooms are on B and C decks, together with the other public rooms, while the dining-room, galley, pantry, etc., are on D deck.

The second class accommodations are similarly arranged on B, C and D decks immediately abaft the first class quarters, while the third class quarters are on the same decks forward. The ship's crew is all berthed on C deck, the sailors being forward, the engine room staff amidships abreast the machinery space and the other help aft.

The cargo is handled chiefly through five large side ports on each side of the vessels at the level of the D deck. Space is reserved forward for cargo on D and E decks and in the hold, two trunked hatches leading up to A deck, where they are served by 50-foot cargo booms of five tons capacity on the foremast. An electric elevator is also installed on the D deck forward, serving the decks below. In the cargo space aft, where the freight is handled entirely through side ports, three electric elevators are installed. On E deck directly abaft the machinery space is a cold storage cargo space of about 20,000 cubic feet capacity for the transportation of perishable goods.

Hull Construction

The principal scantlings of the hull are shown on the midship section, Fig. 9. The stem is of rolled steel finished on the forward edge from the light load waterline to the head, and is carried up to take the foremast stay. The lower end of the shoe piece is of cast steel conforming to the shape of the forefoot. The stern frame is also of cast steel. From 15 feet forward of the propeller post the shoe is gradually raised until the lower rudder pintle is 2 feet above the base line, in order to reduce any damage to the rudder if the vessel should ground. The rudder post extends to the top of the transom frames. The rudder plate is of solid cast steel and the stock of forged steel carried up above B deck, where a hand steering gear is fitted to a crosshead carried on the stock.

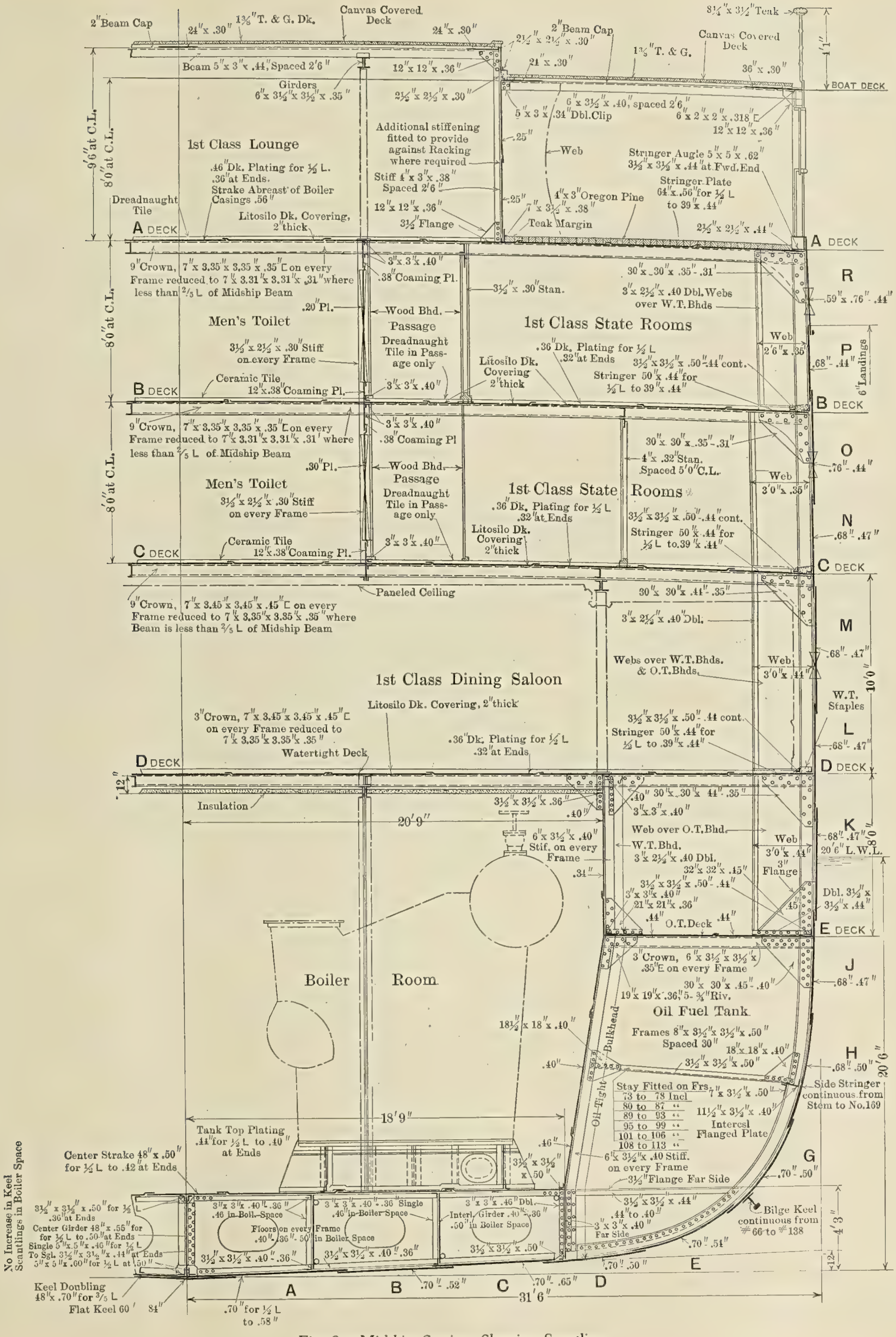

Fig. 9.—Midship Section, Showing Scantlings

Rudder stops are fitted limiting the movement to 35 degrees.

The flat keel plate is 60 inches wide and .84 inch thick, fitted for three-fifths of its length with a doubling plate 48 inches wide and .70 inch thick. The vertical keel is 48 inches deep by .55 inch thick for one-half length, reduced to .50 inch at the ends. The bottom angles are 5 inches by 5 inches by .60 inch, reduced to .50 inch at the ends, while the upper angles are 3½ inches by 3½ inches by .50 inch for one-half length, reduced to .36 inch at the ends. On each side of the center keel are three intercostal longitudinals, the floors placed on every frame extending in one piece from the vertical keel to the bilge. Above the double bottom or between the margin of the inner bottom and E deck there is a longitudinal bulkhead on each side extending from the forward engine room bulkhead to the forward boiler room bulkhead. Below E deck these bulkheads are oiltight and above E deck they are watertight. The capacity of the wing tanks thus formed is 5 percent in excess of the amount of oil to be carried in order to allow for expansion.

The framing consists of 8-inch by 3½-inch by 3½-inch by .50-inch channels spaced 30 inches amidships and 28 inches at the forward end. The frames extend in one piece from the inner bottom to A deck from the stem to the after limits of the strength deck and aft of that they extend to B deck only.

The A deck is a strength deck for one-half the length amidships and is completely plated within these limits. At the limits of the strength deck structure the stresses are transmitted to the deck below by doubling up the side and deck plating and by diaphragm plates fitted between A and B decks. B, C and D decks are completely plated. The deck beams on A and B decks are 7-inch by 3.35-inch by 3.35-inch by .35-inch channels placed on every frame and reduced to 7 inches by 3.31 inches by 3.31 inches by .31 inch where the beams are less than three-fifths the length of the midship beam. On C and D decks the beams are 7 inches by 3.45 inches by 3.45 inches by .45 inch placed on every frame and reduced as above to 7 inches by 3.35 inches by 3.35 inches by .35 inch. On E deck the beams are 6-inch by 3.5-inch by 3.5-inch by .35-inch channels placed on every frame.

The shell plating, as shown in Fig. 9, varies from .76 inch in the sheer strakes at A and B decks to .68 inch in the side plating, the bottom plating being .70 inch thick.

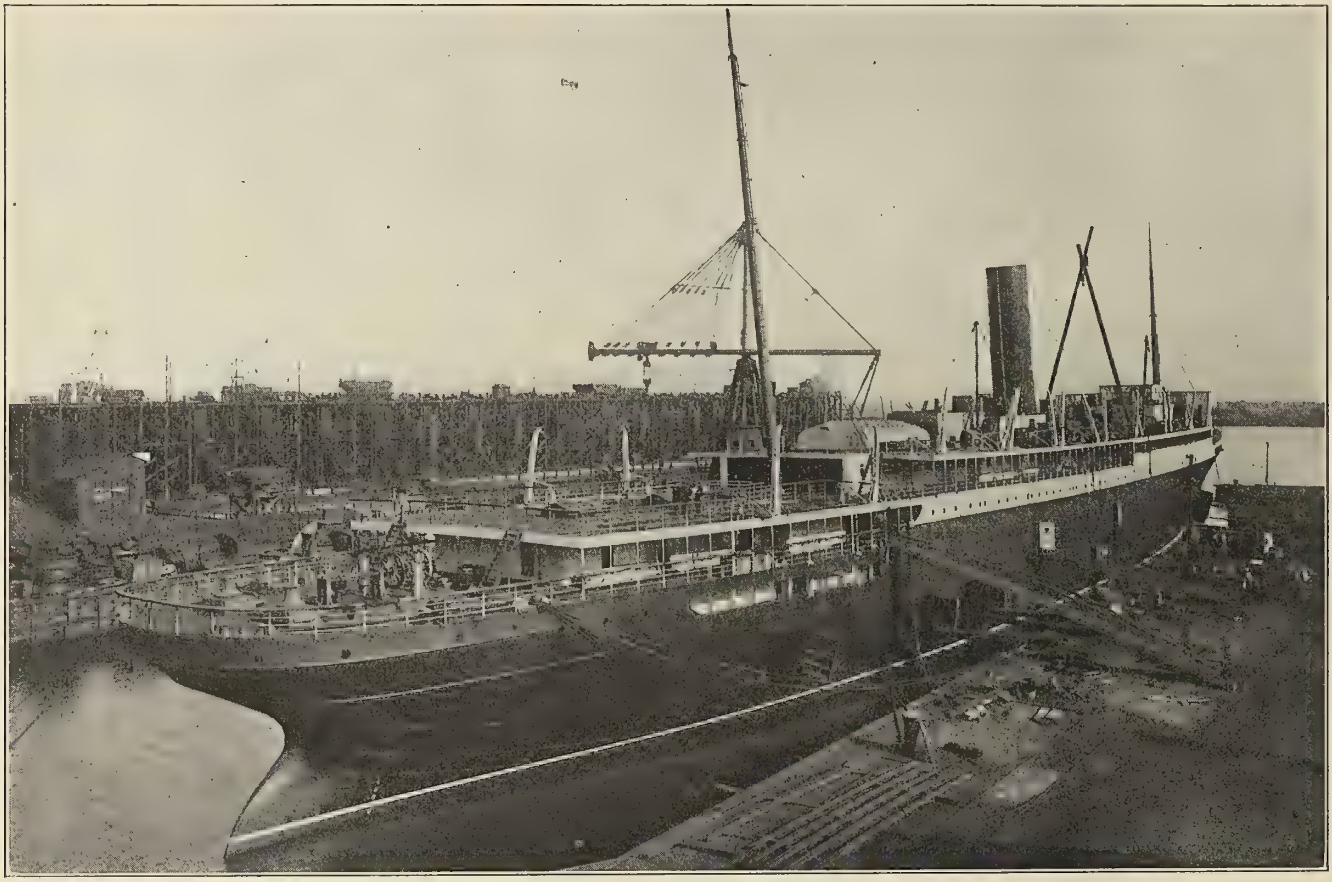

Fig. 10.—View of the *Great Northern*, Taken at the Fitting Out Dock, September 14

Boilers

Steam is supplied at 220 pounds per square inch working pressure by twelve specially designed watertube boilers of the Mosher type, built by the Babcock & Wilcox Company to the requirements of the United States Board of Supervising Inspectors, and also to Lloyds inspection. The twelve boilers are installed in two watertight compartments, in each of which the boilers are arranged in rows of three facing the center line of the ship, and thus providing a fore and aft fireroom 11 feet 2½ inches wide by 65 feet long. The total space occupied by the boilers is therefore 130 feet by 41 feet 6 inches.

The overall dimensions of the boilers are: Width, 15 feet 7⅜ inches; length, 11 feet 8 7/16 inches, and height over the steam drums, 14 feet 2½ inches. Each boiler contains approximately 5,000 square feet of heating surface, making the total heating surface for the vessel about 60,000 square feet. The steam drums are 54 inches diameter with the heads bumped to a radius of 54 inches and flanged by hydraulic pressure. The water drums are oval in shape. Each boiler has 969 generating tubes 2 inches

Fig. 11.—Launch of the *Northern Pacific*

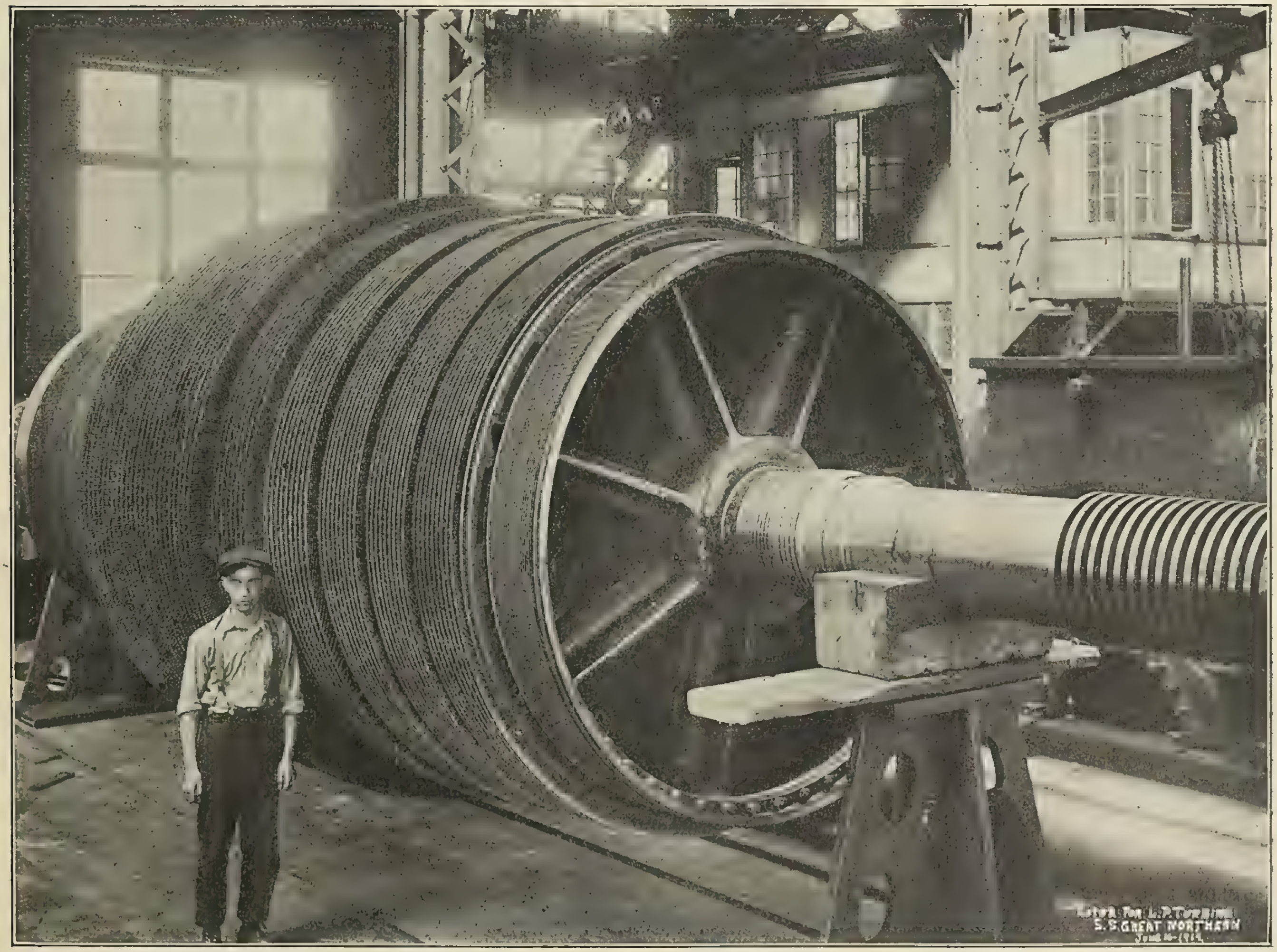

Fig. 12.—Rotor of Low-Pressure Turbine for the *Great Northern*

in diameter of No. 9 B. W. G. They are given a straight curvature and are expanded into the steam and water drums.

The boilers operate under forced draft on the closed stoke-hold system. Three turbo blowers, manufactured by the B. F. Sturtevant Company, Hyde Park, Mass., are installed in each fireroom. The turbines are direct connected to 34-inch high speed cone fans and each unit delivers 30,000 cubic feet of air per minute against a pressure of 2 inches of water. The units will operate at 180 pounds steam pressure and are equipped with emergency safety governors. Two of the units in each fireroom are sufficient to supply the draft at a speed of 23 knots, the third unit being reserved as a spare. A watertight door connects the forward and after firerooms and the after fireroom also communicates with the engine room by means of a watertight door.

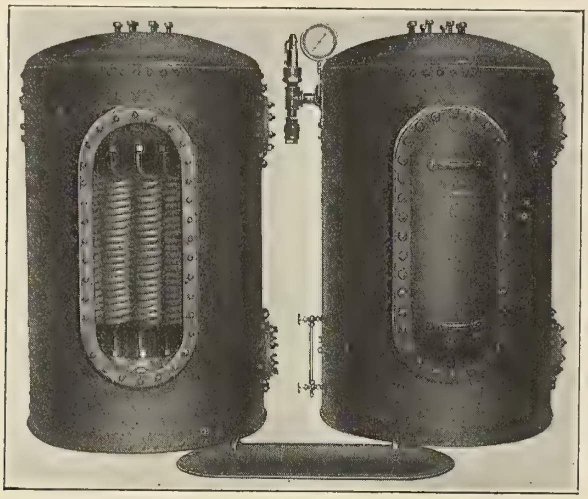

Fig. 13.—Reilly Multi-Coil Feed Water Heater

The Koerting mechanical oil burning system, supplied by Schutte & Koerting Company, Philadelphia, Pa., is used for firing the boilers. In this system the oil is forced by means of pumps through superheaters to the burners, where it is atomized by mechanical action. For the purpose of transferring the oil from the storage tanks and putting it under a constant steady pressure, the system is equipped with a pumping outfit consisting of two steam driven pumps, an air chamber and all necessary valves and fittings. One of the pumps is always kept in reserve in the event of mishap to the other, thus insuring practically uninterrupted service.

The oil is taken from the storage tanks and on its way to the pump passes through duplex suction strainers. The pump puts the oil under the required pressure, a large air chamber being provided to take up the pulsations of the pump, and then passes through a superheater using live steam to heat the oil to the proper temperature. Evaporation of the oil is prevented by the pressure on the pumps being kept in accordance with the temperature. On the way from the superheater to the burners, the oil, which is then under high pressure and of the required high temperature, is again strained in a high-pressure duplex strainer. The burners are of the centrifugal spray type fastened to adjustable air registers provided with air admission slides to regulate the air supplied for combustion, so as to secure a proper mixture of air and oil for complete combustion. No steam or air is required for atomizing the oil, as the moment the oil leaves the spray nozzles the pressure is removed and the oil is thoroughly atomized and mixed with the incoming air.

It is obvious that the use of oil fuel, thus eliminating the trimming of coal and the method of installing the boilers in a fore and aft fireroom which is made possible by the adaptability of the boilers to be set athwartship, provide an extremely compact and accessible boiler arrangement for a plant of this size. The products of combustion are taken off by two smokestacks about 112 feet high above the base line, each group of six boilers being connected by suitable uptakes to a single stack.

Main Engines

The propelling machinery consists of one high-pressure and two low-pressure Parsons turbines arranged on three shafts and capable of developing a total of about 25,000 shaft horsepower at 325 revolutions per minute. Steam from the boilers is supplied through two main pipes connecting to the inlet belt of the high-pressure turbine on the center shaft, and also to the inlets of the two low-pressure turbines on the wing shafts for maneuvering purposes. Astern turbines are incorporated in each of the low-pressure turbines and the steam connection to the astern turbines and the low-pressure ahead turbines lead from a double maneuvering throttle at the working platform so arranged that in maneuvering ahead or astern both valves will be operated from a hand wheel. The main steam connection to the high-pressure turbine is controlled with a single balanced throttle valve at the working platform.

The high-pressure turbine is 21 feet 7½ inches long overall, the outside diameter of the drum of the rotor being 5 feet 8 inches. The cylinder is of close-grained cast iron and the rotor drum an open hearth weldless steel forging. The wheels are of cast steel annealed and the shaft of open hearth forged steel. There are four stages of expansion with sixteen rows of blading in each stage, the diameters of the rotor at the tips of the blades of each stage being respectively 5 feet 11 inches, 6 feet ¼ inch, 6 feet 2 inches and 6 feet 4½ inches.

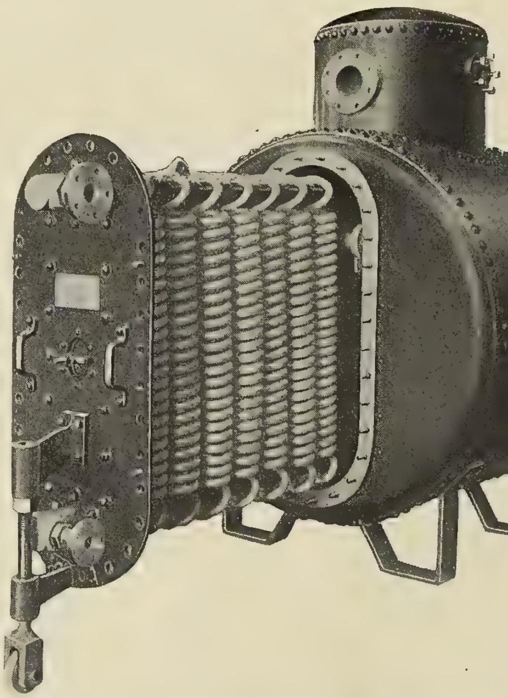

Fig. 14.—Reilly Navy Type Evaporator

The total length of each of the low-pressure ahead and the astern turbines is 32 feet 2 inches, the low-pressure drum being 7 feet 8 inches outside diameter and the astern

drum 6 feet 7 inches diameter. There are six stages of expansion in the low-pressure turbines and four stages in the astern turbines.

The construction of the turbines conforms to the latest Parsons practice in every respect. The line shafting is 12¼ inches diameter. Lubrication of the turbine thrust and spring bearings is by oil supplied by a gravity tank of 2,000 gallons capacity so placed as to give a pressure at the bearings of 10 pounds per square inch. This tank is supplied by two steam-driven pumps which draw from the inner bottom or from drain tanks. Two oil coolers of the quadruple flow type, having a cooling surface of about 360 square feet, are installed in the engine room for cooling the main engine lubricating oil. The circulating water is taken from the oil cooler circulating pump with emergency connections from the fire and bilge pumps or the main circulating pumps.

The two main condensers each have 13,046 square feet of cooling surface and contain 6,018 tubes ¾-inch diameter and 11 feet long between tube sheets, with a thickness of No. 16 B. W. G. An auxiliary condenser is provided for port use. There is one air pump for each condenser of the twin beam, vertical, single-acting type, supplied by the Blake & Knowles Steam Pump Works, with air cylinders 32 inches diameter and steam cylinders 14 inches diameter with a stroke of 21 inches. The auxiliary air pump is of the vertical simplex featherweight type 7½ inches by 14 inches by 10 inches. The cooling water for each condenser is supplied by a 26-inch engine-driven centrifugal pump.

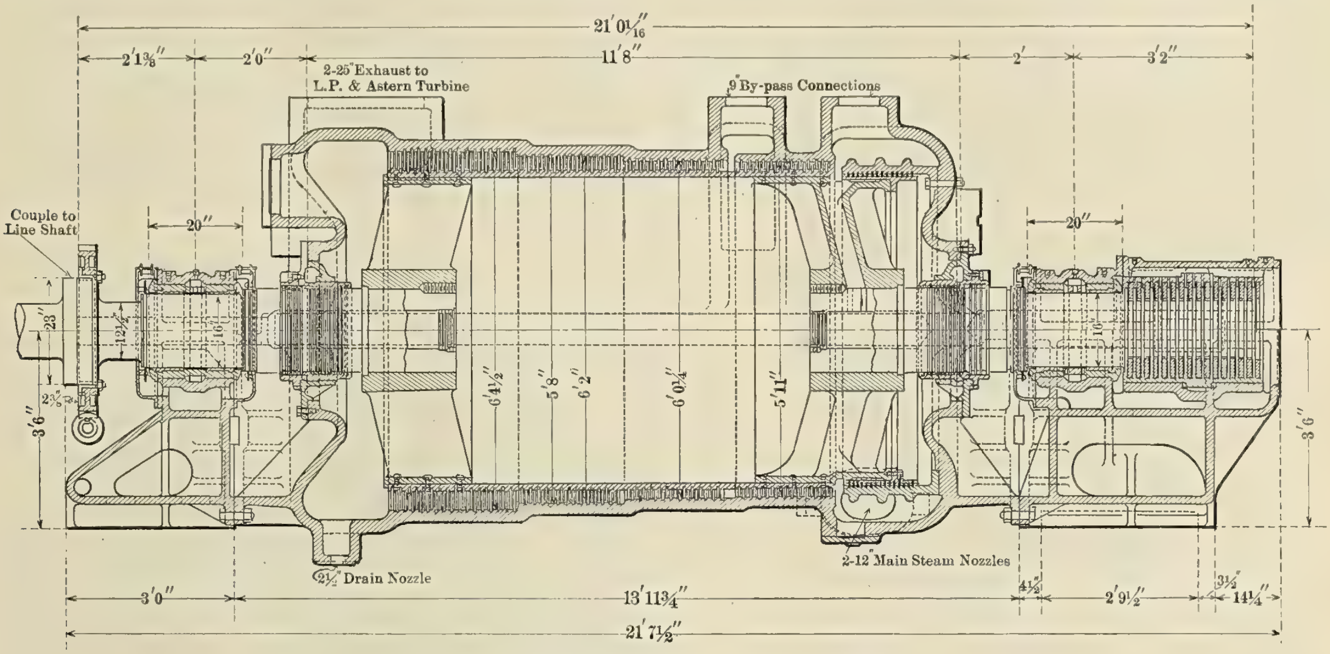

Fig. 15.—Section Through High-Pressure Turbine

AUXILIARIES

The following pumps were furnished by the Blake & Knowles Steam Pump Works:

Four main feed, vertical simplex, Weir type, 15½ inches by 9¾ inches by 24 inches.

Two auxiliary feed, vertical duplex, 12 inches by 8½ inches by 12 inches.

Two bilge and ballast, vertical duplex, 7½ inches by 9 inches by 10 inches.

Two lubricating oil, vertical simplex, 6 inches by 8 inches by 12 inches.

Four fuel oil service, horizontal duplex, 7½ inches by 5 inches by 10 inches.

Two oil transfer, vertical simplex, 6 inches by 8 inches by 12 inches.

Two brine, vertical duplex, 5¼ inches by 5 inches by 5 inches.

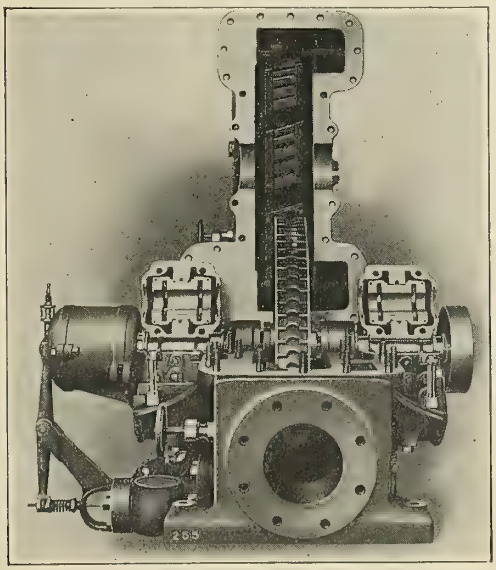

Fig. 16.—Terry Turbine Opened for Inspection

Fig. 17.—Terry Turbo Generating Set

One donkey boiler feed, horizontal simplex, 4½ inches by 2¾ inches by 6 inches.

One evaporator feed, horizontal simplex, 4½ inches by 2¾ inches by 6 inches.

Two fresh water, horizontal simplex, 5½ inches by 5½ inches by 7 inches.

One ice water circulating, horizontal simplex, 3½ inches by 3½ inches by 4 inches.

The auxiliaries also include two 4-inch Worthington centrifugal sanitary pumps designed to handle 500 gallons of salt water per minute for sanitary purposes against a head of 100 feet. These pumps are driven by a standard Terry type "Z" turbine, delivering about 20 horsepower at 2,750 revolutions per minute and designed to operate with normal steam conditions of 175 pounds initial pressure and 10 pounds back pressure, although the turbines

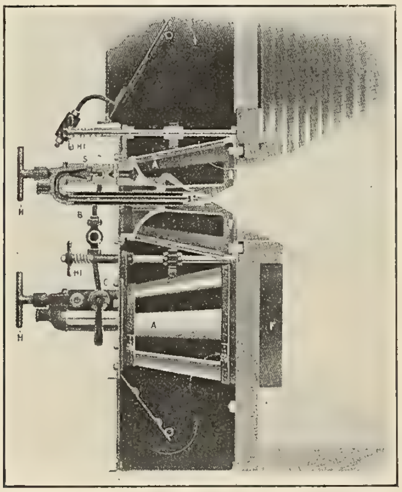

Fig. 18.—Koerting Mechanical Oil Burner Installed in the Boilers

are capable of delivering the required horsepower with 220 pounds initial steam pressure and 5 pounds back pressure.

The feed water heaters, of which there are two, are of the Reilly multicoil type furnished by the Griscom-Russell Company, New York. They are 48 inches diameter by about 7 feet high. Each of these heaters can handle 150,000 pounds of feed water per hour to a discharge temperature of 208 degrees F. when furnished with steam at 5 pounds pressure. The shell is of boiler steel with the door frame and door of pressed steel. The heating element consists of seamless drawn copper tubing free from brazing and gaskets, the connections being made of the manufacturers' patented copper-faced union joint.

Another auxiliary furnished by the Griscom-Russell Company is a Reilly multicoil horizontal Navy type evaporator 4 feet 4 inches diameter and 6 feet 7 inches high, capable of furnishing 25 tons of pure distilled water per twenty-four hours. The shell, heads, door and dome are of open hearth steel, the manifolds and heating surface of brass and copper respectively. The heating surface is of the manufacturers' special Navy type copper coils with quick detachable flanged joints.

There is a complete CO_2 refrigerating plant, manufactured by J. & E. Hall Company, Ltd., consisting of two No. 9 machines for refrigerating the cargo holds and ship's stores.

Two hot-water generators are provided, one for heating fresh water and one for salt water service. These are of the straight tube, multipass type manufactured by the Griscom-Russell Company. Each unit has a capacity of 150 gallons of water per minute heated from 50 to 130 degrees F. with steam at 5 pounds pressure. The tube plates are of brass in the salt water heater and steel in the fresh water heater.

Electric Plant

The electric plant consists of four 35 kilowatt 110-volt generators, manufactured by the Diehl Manufacturing Company, direct connected to Terry type "GM" turbines manufactured by the Terry Steam Turbine Company, Hartford, Conn. The turbines themselves are designed to operate normally with 200 pounds steam pressure and a 28-inch vacuum, although they will carry the required load with 175 pounds steam pressure and a 26-inch vacuum, and are capable of operating with an initial pres-

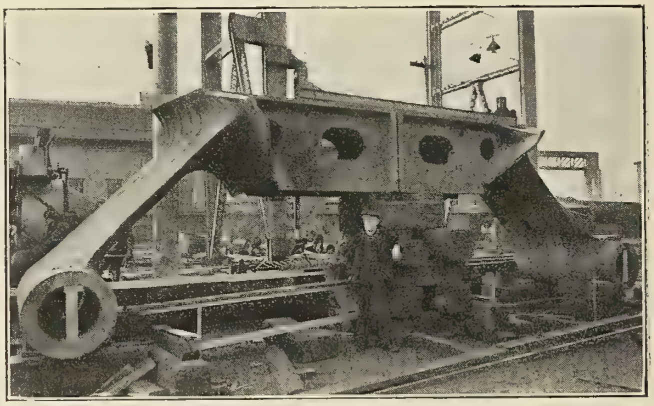

Fig. 19.—Cast Steel Spectacle Frame; Weight 22 Gross Tons

sure of 220 pounds. For emergency purposes they can also be operated with 175 pounds steam pressure when exhausting against a back pressure of 10 pounds. The normal operating speed of these sets is 3,200 revolutions per minute.

This plant supplies current not only for lighting the ship, but also for operating the five freight elevators and many of the appliances in the galley, as well as for operating a Willets-Bruce automatic whistle with which these vessels are equipped.

Passenger Accommodations

In arranging the passenger accommodations on the *Great Northern* and *Northern Pacific* the needs of the patrons of the line have been carefully considered and every feature which could add to their comfort and pleasure has been incorporated. Few modern passenger ships of the same tonnage and type can boast of more commodious promenade decks or of more tastefully decorated or conveniently arranged public and private rooms.

As has been stated before, the A deck is given over almost wholly to the first class public rooms. At the forward end of the superstructure is a curved steel bulkhead or shield which divides the first class quarters from those occupied by the third class passengers and crew and which also serves to protect the passengers from any spray that might come aboard. For this purpose the shield is faced with heavy half-round bars intended to break up a solid wave or diminish its force when breaking over the deck.

For 125 feet aft of this shield the deck is protected by sliding glass windows of the Laycock patent type, so that the passengers can enjoy the deck space for dancing or promenading in all kinds of weather. Within this glass enclosure are the main lounge, observation room and lob-

bies, all pleasingly decorated and finished in the Colonial style. The color scheme in the observation room is green and old ivory, and in the lounge there are old rose carpets and tapestries. In both rooms there are attractive bay windows on each side fitted with French windows, while skylights overhead aid materially in lighting and ventilating the rooms. In the lounge a large fireplace ready for service adds much to the comfort of the traveler.

Just abaft the observation room is the main entrance and stairway leading to the decks below, while abaft the main lounge alongside the machinery hatches are a number of bachelor staterooms with private toilets and showers between them.

Further aft on A deck is the first class smoking room, the joiner work of which is of oak finished in natural colors. The floors are of Dreadnought tiling of soft, warm colors harmonizing with the russet brown leather furniture and oak joiner work. In this room, as well as in the lounge, there is a large open fireplace ready for service. Just abaft the smoking room is a deck veranda, protected at the sides with glass, but open towards the stern. The furniture on the veranda is of Windsor design.

On the deck below are located special suites of rooms which include parlors, single and double bedrooms, as well as the ordinary first class staterooms. The rooms are equipped with every accessory which a traveler might desire, with public and private bathrooms conveniently arranged. All of the hallways, alcoves and lobbies throughout the passenger quarters are spacious and are covered with Dreadnought tiling and rugs harmonizing with the style and finish of the joiner work. The staterooms are finished in white enamel with doors of mahogany paneling, and are fitted with two berths and a sofa lounge. There are also writing rooms and a barber shop on this deck.

The first class quarters on the C deck consist wholly of staterooms and toilets and bathrooms. The staterooms are of the same order as those on the B deck, although there are no suites. As the main entrance to the first class quarters is on this deck, the purser's office is located forward at the main stairway, which leads down to the main dining-room on the deck below.

The dining-room is most attractively decorated in the Colonial style, with alcoves along the sides of the room. The round port lights are hidden behind white latticed windows and panels on the walls are fitted with large French plate glass mirrors. The flooring here is also covered with Dreadnought tiling. The pantry and galley are immediately aft of the dining-room and are thoroughly ventilated by exhaust fans of sufficient capacity to change the air every two minutes and also to change the air in the dining-room every seven minutes.

The arrangements for the second class passengers are equal to most of the present first class coastwise ships. The staterooms are furnished along the same lines as the first class rooms and the ventilation of these accommodations is part of the same system that ventilates the first class rooms. The heating and ventilating are on the thermo-tank system.

All of the stateroom bulkheads throughout the ships are constructed of "Nevasplit" paneling 7/16 inch thick, supplied by the Keyes Products Company, New York. In all, about 30,000 feet of this paneling was required for both ships. Below the upper or weather deck the decks are covered with from 2 inches to 3 inches of "Litosilo," a composition which adds materially to the sanitary conditions of the passenger quarters, as it does not absorb moisture to the extent of a wood deck, and is thoroughly durable.

Fire Alarm System

One of the most interesting and important of the numerous safety devices installed on these ships is the Aero automatic fire alarm system, which responds to any sudden rise of temperature in the space which it reaches, as was described in our September issue. The layout of the Aero system on these ships differs slightly from the steamship equipments heretofore installed. There are three centers of distribution or switchboards, which are placed on deck C, the locations being forward at the stairways used by the officers and ship's crews, midships in the vicinity of the first class companionway, and aft at the stairway in the second cabin. From these switchboard cabinets the copper tubing circuits radiate, being threaded through the various compartments, staterooms and lockers, returning ultimately to the switchboard, making a complete loop in every instance. One end of the loop is in a sensitive diaphragm which, in the case of fire in the section covered, the air in the tube expanding, moves to the contact point, thus closing the electric circuit. The other end of the tube is connected to a testing valve by which the exact condition of each circuit and all its electric connections can be accurately determined at any time by the officer in charge.

There are two annunciator boards, one in the engine room—a cabinet with a glass front on which is outlined the diagram of the ship—which indicates the exact location on the ship and the deck affected in the case of fire outbreak. A duplicate of this apparatus is placed in the pilot house, so that in the event of fire in any portion of the ship affecting any circuit a general location, whether forward, midships or aft, starboard or port, and the deck, is shown by the indicators. A fire bell in the engine room and a "still alarm" buzzer in the pilot house sound to call attention to the indicators.

The sub-switchboards mentioned in the foregoing each contain a buzzer for a "still alarm," and in the event of fire will call attention of the stewards, officers, or any of the ship's people to that cabinet, where is indicated the exact location of the outbreak. In the event of fire aft affecting the after board, no indication is given in the midships or forward boards, but the main annunciator in the engine room and the duplicate in the pilot house both register. Thus, the same operation takes place should the fire affect the circuits of the midships board or the one forward, No alarm is given on any of the switchboards except the one situated in the area where the fire occurs. This minimizes the danger of panic among either passengers or crew, and as the Aero picks up its alarms "within seconds" of the outbreak, it enables the fire to be dealt with in its incipient stage, and thus extinguished without the necessity of giving a general alarm.

While the installations of the Aero system on shipboard up to date have been mostly on passenger-carrying boats, these Great Northern liners having considerable cargo space are protected throughout, the Aero tubing being run along the steel ceilings in the lap-joint of the steel plates, thus lying out of harm's way and at the same time most advantageously placed for gathering heat effects and responding to the rapid rise of temperature.

Deck Auxiliaries

The steam steering gear, windlass, capstans and hoisting winches were all supplied by the American Engineering Company, Philadelphia. The steering engine is of the differential type, with cylinders 14 inches diameter by 14 inches stroke, controlled by an automatic reverse valve. The engine can be operated directly at the engine or by telemotor from the pilot house.

Launching Calculations

Preliminary and Final Curves and Data for Launching Large Vessels

BY G. H. BARBER

The purpose of this article is to set down the procedure of preparing the launching curves and other necessary data required by the builders preparatory to the launching. The methods described are those used by the writer in preparing preliminary and final curves and data for the launching of vessels of from 6,000 to 13,000 tons launching weight. It is thought that the methods and forms used may be of interest and use to those who have similar problems.

Declivity of the Keel

It is desirable to keep the ship as near the ground as possible, giving consideration to leaving ample working space under the keel at the after end and also to seeing that work on the after end is not hindered by the water, thereby preventing excessive heights of the forward and after blocks. The lower the initial position of the ship the greater the buoyancy obtained on a given run, and hence a lesser tendency to overturn about the end of the ways. If the blocks are built at a lesser declivity than the ways the height of the foremost block must be such that the forefoot will not strike the slip.

Assuming a certain launching tide and the end of the groundways fixed, the greater the declivity of the blocks the less the distance run before pivoting and the greater the moment against tipping, but the greater the pivoting pressure and thrust from the groundways.

Declivity of the Ways

With the same launching tide, the greater the declivity of the ways the less is the distance the ship must run after pivoting, but the greater the thrust from the after end of groundways.

The greater the ways' declivity the greater will be the tendency to move down the ways. This, in conjunction with the probable time of year of launching, as affecting the grease and thereby the coefficient of friction, must be considered in connection with the available or intended holding and releasing devices.

A point worth investigating, especially in vessels of great length, is to see that the bottom of the ship at the after end does not dig into the fairway bottom before pivoting takes place. This is done by drawing the ship at the correct slope in position on the ways immediately before pivoting, and then drawing the contour of the sea bottom at correct elevation and see if the clearance under the ship is sufficient. While this is properly remedied by dredging, cases may arise where it is preferable and possible to alter the declivity of the ways.

It is necessary, as a rule, to investigate the launching curves for one declivity of the keel only. If more than one is investigated the work for the second duplicates the procedure for the first. On the other hand, it is usual to investigate for two sets of launching declivities—one being what is considered the maximum limit and the other somewhat less. Assuming then a certain launching declivity, the usual launching curves are obtained as described below and then modified to suit varying tides, launching declivities and weights.

The Distance Between Ways

In this country, where two ways, one on either side of the keel, are used for stern launchings, it is safe to make the distance between ways about one-third of the breadth of the ship. The exact distance is governed by the location of the longitudinal bulkheads or stiffeners, which will transmit and distribute the upward thrust of the ways into the structure. In yards where permanent structures are set up to take the groundways, allowance should be made in the width for a shift, either inboard or outboard, of the centerline of the ways to meet varying fore and aft structural arrangement of the different vessels to be launched.

Locating the Forward and After Poppets

Before proceeding with the launching curves it is necessary to locate the forward poppet. The after poppet will likewise be discussed. There are three considerations which ordinarily make it desirable to locate the fore poppet as far forward as possible.

1. The moment of weight about the fore poppet is increased in a greater proportion than the moment of buoyancy about the same point by so doing. This causes the boat to pivot later in its run, thereby decreasing the pivoting pressure in amount and in duration.

2. A gain in length of sliding way is made. The greater the length of sliding ways available the less width will be required to keep the pressure on the ways per square foot within safe limits. This consideration is very important in the case of battleships where the weight per foot of length is very much greater than that of merchant vessels. Wide ways increase very much the cost of handling and fitting the packing between the sliding ways and ship and removing the same after launching.

3. The "overhang" forward is reduced. This is essential, as the weight of the overhang must be transmitted through the structure to the packing. The structure should not be too greatly strained, nor should too great a weight be concentrated over the forward packing.

Considerations 2 and 3 apply also to the location of the after poppet.

It will be seen that the shape of the vessel forward, the distance between the center lines of ways and the kind of fore poppet to be used will determine the forwardmost point at which the fore poppet can be located.

Locating the End of Groundways

A tentative position for the end of the groundways may be selected by running the groundways, if possible, to the point at which the depth of water over the ways at mean high tide is approximately equal to the probable forward launching draft of the vessel. As the moments about the end of ways are easily obtained changing the location of the end of the groundways, to gain moment against overturning is an easy matter. If there are physical reasons for not extending the groundways, the anti-tipping moment may be increased otherwise, as elsewhere explained.

The Launching Curves

The ultimate purposae of the curves is to ascertain the points of action and the amounts of the static forces acting on the ship during launching. The tendency of the ship to overturn about the after end of the groundways is ascertained, as well as the point of run at which the buoyancy, acting upward about the fore poppet, over-

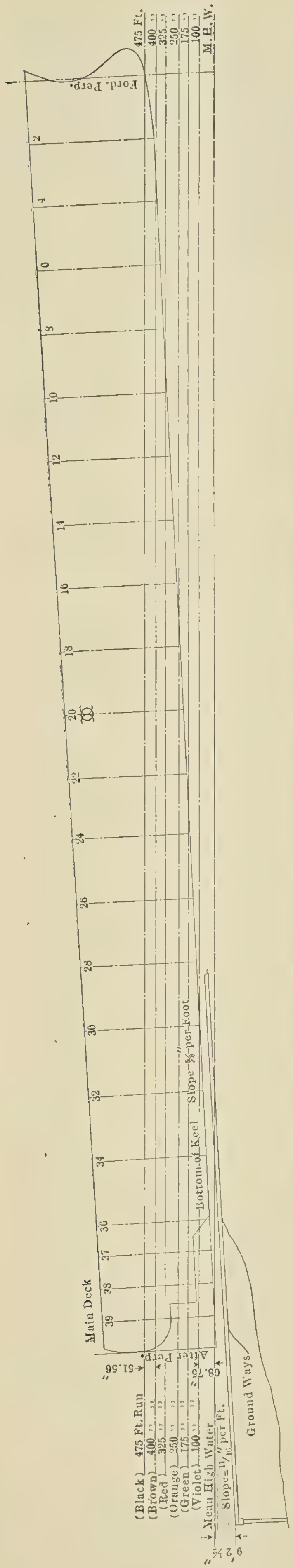

Fig. 1.—Profile of Ship on Ways before Launching, Showing Waterlines at Different Lengths of Run

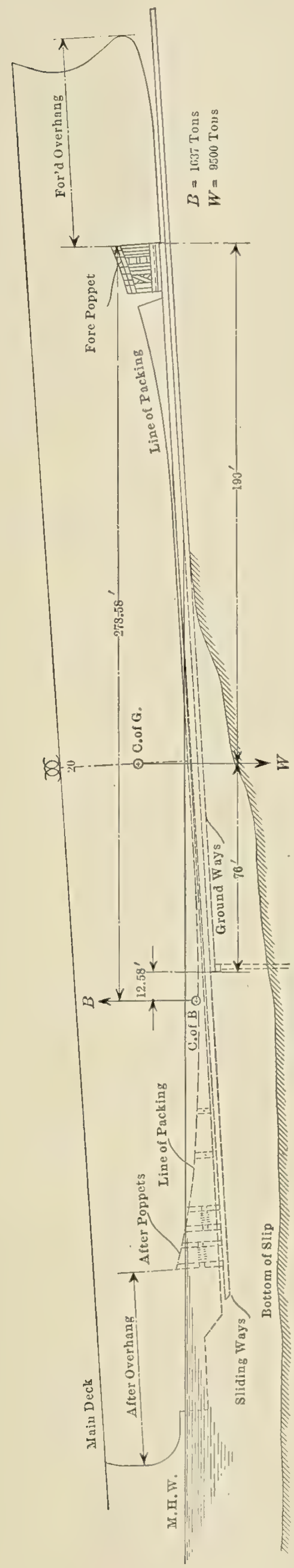

Fig. 2.—Ship after 250 Feet of Run, Showing Forces Acting, Poppets, Overhang, Etc.

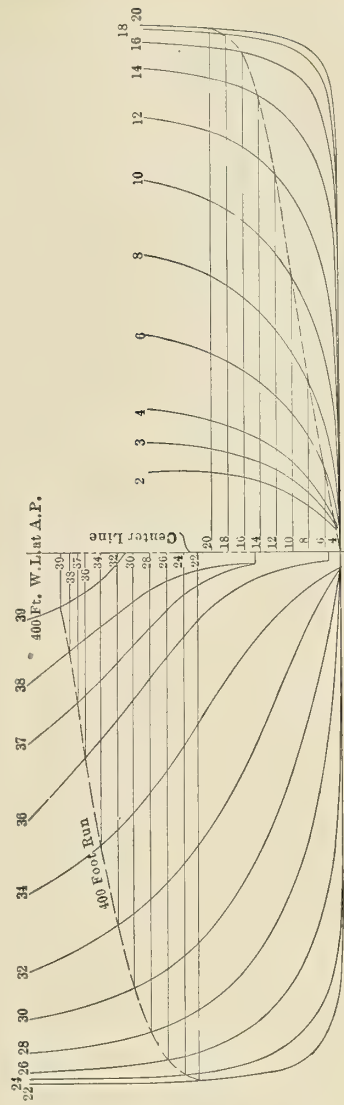

Fig. 4.—Launching Body, Showing Submerged Sections for 400-Foot Run

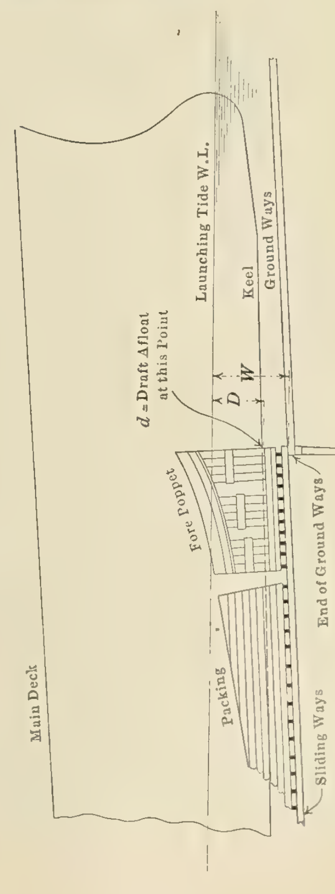

Fig. 3.—Sketch Showing "Drop"

comes the weight acting downward about the same point, together with the amount of weight, unsupported except for the fore poppet, at the moment when this turning or pivoting begins.

The curves required are as follows:

A—Weight curve.
B—Inclined displacement or buoyancy.
C—Moment of buoyancy about fore poppet.
D—Moment of buoyancy about after end of ways.
E—Moment of weight about after end of ways.
F—Moment of weight about fore poppet.
G—Reaction of groundways.

These curves are all laid off on the same base of "Distance Run in Feet." The vertical scale for A, B and G is in tons, and for C, D, E and F is in foot tons.

Weight Curves and Weight Moment Curves

The probable launching weight is calculated for those parts of the hull, machinery, fittings, dunnage and ballast which it is estimated will be in place at launching. This is carefully done, the longitudinal center of gravity being determined at the same time. A straight line is then drawn across the curve sheet at the height on the displacement scale corresponding to this weight. Then the position of the center of gravity of the weight being known in respect to the end of the ways and the values for the fore poppet, moment of weight about the fore poppet and about the end of groundways are calculated in foot-tons and the curves are drawn in.

Buoyancy Curve and Buoyancy Moment Curves

The longitudinal profile is drawn at the declivity of the keel blocks and the mean high water line drawn in at its correct elevation relative to the ship in its initial position. For the purposes of these curves it may be assumed that the ship stands still and that the waterline rises at a rate corresponding to the declivity of the ways —i. e., an 80-foot run at 9/16-inch slope equals a rise in the waterline of $9/16 \times 80 = 45$ inches. The designer's even numbered stations are now drawn in the profile and a body plan using these stations is made to a convenient scale. Waterlines corresponding to runs of, say, 80, 160, 240, 320, etc., feet at mean high water are drawn across the profile. The points of intersection with the forward and after perpendicular are transferred to the body plan center line. The vertical distance between the two points for all the waterlines is divided into the number of equal parts corresponding to the number of stations used. The points so found will give the heights of the waterlines on the various stations for the different distances run.

It may be mentioned that the heights on the perpendiculars for the selected distances of run may be calculated from the known elevations. In this event the profile method serves as a good check, as the correct height of the waterline across *any* station may be scaled from the profile.

Since the boat slides without list, horizontal lines are drawn through these series of points to the proper stations in the forward and after body. It has been found that a different colored ink used for all lines pertaining to each distance run greatly facilitates this part of the work.

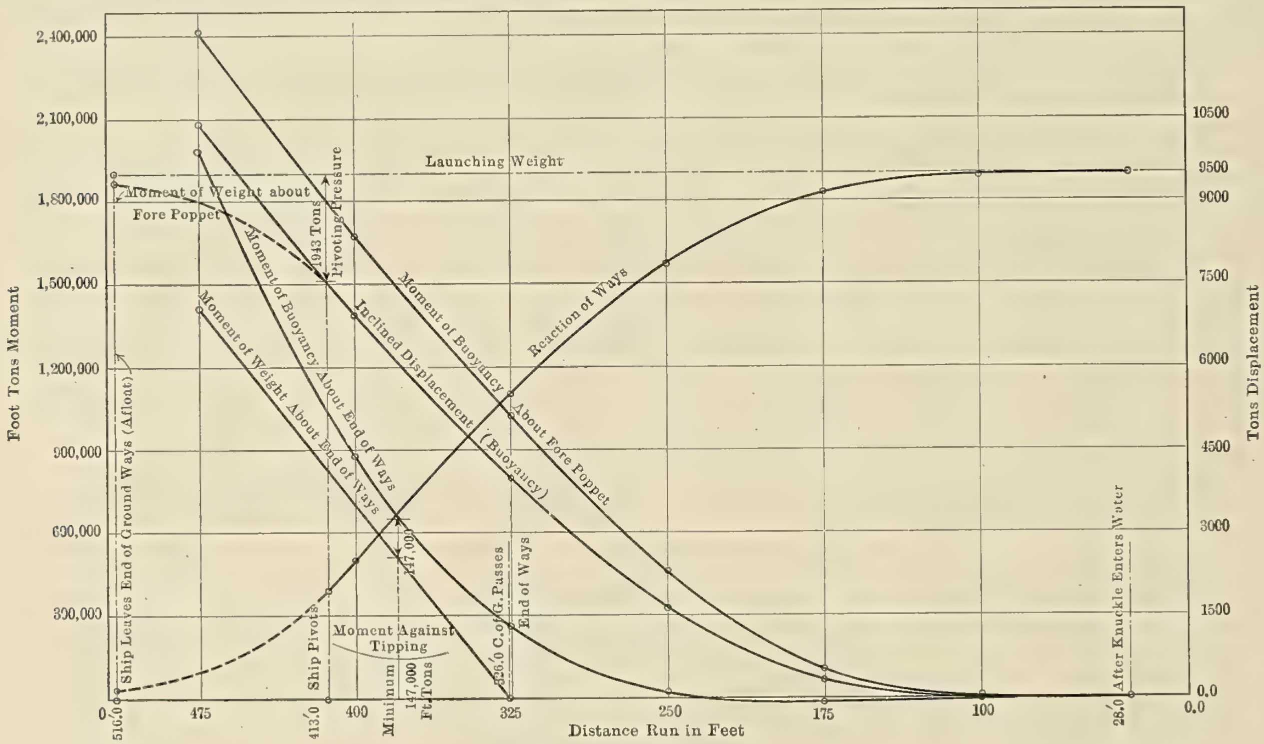

Fig. 5.—Launching Curves

The submerged half sections having thus been drawn for the different runs, the half section areas for all runs are obtained by the careful use of the planimeter. (See Table I.) The functions of areas are put through the rule, trapezoidal is used by the writer as sufficiently accurate, and the inclined displacement and fore and aft position of the center of buoyancy obtained (see Table II) for each of the successive runs.

The values for the early runs are not absolutely necessary, but as they are easily obtained and give additional points for the plotting of the curves, they are usually plotted.

The values for the moments of buoyancy about the fore poppet and about the end of the ways are now worked out and the curves drawn. (See Table III.) These curves should run in smooth and fair. If a point on any curve is "hard" the calculations for this point should be run through and the error found. It will be noted in

TABLE I.—TABULATION OF PLANIMETER READINGS, 400 FEET RUN (BROWN).

STATION.	First Reading.	Second Reading.	Difference.	Mean.	STATION.	First Reading.	Second Reading.	Difference.	Mean.
39	(b) 1050 (a) 1000	(c) 1097 (b) 1050	1st 50 2d 47	48	22	4732 3157	7857 6285	1575 1572	1573
38	2032 1867	2195 2032	165 163	164	20	9253 7857	10651 9253	1396 1398	1397
37	2457 2195	2720 2457	262 263	262	18	11858 10651	9405 8200	1207 1205	1206
36	3360 3190	3784 3612	422 424	423	16	9169 8200	10140 9169	969 971	970
34	4524 3784	5268 4524	740 744	742	14	4917 4220	5612 4917	697 695	696
32	6342 5268	7420 6342	1074 1078	1076	12	6034 5612	6458 6034	418 424	421
30	8773 7421	10138 8773	1352 1365	1359	10	6672 6458	6886 6672	214 214	214
28	11693 10138	14812 13258	1555 1554	1555	8	6965 6886	7045 6965	79 80	79
26	16466 14802	3493 1830	1664 1663	1663	6	7055 7045	7063 7055	10 8	9
24	3160 1493	11493 9819	1667 1674	1670	4	....	....	....	0.0

Table I shows a convenient form for keeping the planimeter readings. (a) is for the original setting of the planimeter; (b) is the reading after having gone around the area bounded by station No. 39 and the 400-foot waterline; (b) is then used as the initial reading of the second round and (c) is the reading after the second round. The differences can be quickly obtained and likewise the mean reading. This mean reading is the "Function of Area" in Table II. As a rule the last reading on one station may be used as the initial reading on the next station.

TABLE II.—AREA AND BUOYANCY SHEET—400 FOOT RUN (BROWN)

Station No.	Function of Area.	Multiplier.	Multiple of Area.	Lever Arm.	Function of Moments.
4	0	½	0	8	00
6	9	1	9	7	63
8	79	1	79	6	474
10	214	1	214	5	1070
12	421	1	421	4	1684
14	696	1	696	3	2088
16	970	1	970	2	1940
18	1,206	1	1206	1	1206
20..	1,397	1	1397	0	Sum = 8525
22	1,573	1	1573	1	1573
24	1,670	1	1670	2	3340
26	1,663	1	1663	3	4389
28	1,555	1	1555	4	6220
30	1,359	1	1359	5	6795
32	1,076	1	1076	6	6456
34	742	1	742	7	5194
36	423	¾	317	8	2536
37	262	½	131	8½	1113
38	164	½	82	9	738
39	48	½	24	9½	228
A. P.	00	¼	00	10	000
			15184		Sum = 38,582 —8,525 30,057

Constant for Displacement $= \dfrac{\text{Planimeter factor} \times \text{scale factor} \times \text{distance between stations} \times \text{number of sides}}{\text{Cubic feet per ton (actual)}}$

$$= \frac{.02 \times 16 \times 25.5 \times 2}{35.439} = .4605$$

Displacement $= .4605 \times 15184 = 6{,}992$ tons.

Center of Buoyancy Aft of Station 20 $= \dfrac{30057 \times 25.5}{15184} = 50.47$ feet.

Fig. 5 that the moment of buoyancy about the end of ways crosses below the base line. This is due, of course, to the buoyancy obtained before the end of the ways is reached. This curve will start at 0 foot-tons, where the ship just enters the water, and will cross the base line, becoming positive at the distance run for which the center of buoyancy is just at the end of the groundways.

The intersection of the curve of moment of buoyancy about the fore poppet and the straight line representing the moment of weight about the fore poppet will, of course, give the point at which the stem will commence to rise, turning about the fore poppet, or, as we say, the vessel will pivot. The difference between the weight and buoyancy at this point is the weight concentrated on the fore poppet, and is called the pivoting pressure. Since this is the maximum pressure on the fore poppet, the pressure varying from this maximum to a minimum when the fore poppet is at the end of the groundways, it is not generally considered necessary to calculate the poppet pressures beyond the pivoting point, although this can be done. The fore poppets being designed for this maximum pressure will, of course, be sufficiently strong for the varying lesser pressures. Therefore the curves of reaction on the ways and actual buoyancy need not be calculated beyond this point, but are drawn in approximately, as shown dotted in Fig. 5, from the two known points—i. e., at pivoting and just when afloat.

The reaction of the ways curve shows in tons the weight which the ways are supporting. This is equivalent

TABLE III.—LAUNCHING CALCULATIONS— SUMMARY OF VALUES FOR CURVES: Slope of keel, 5/8" to foot; slope of warp, 11-16" to foot.

Distance Run in Feet.	Inclined Displacement (Buoyancy)	C. of B. Aft of Midship Section.	C. of B. from End of Ways	Moment of Buoyancy About End of Ways.	Distance from C. of B. to the Fore Poppet.	Moment of Buoyancy About Fore Poppet.	Distance of C. of G. from End of Ways.	Moment of Weight About End of Ways
	(Tons)	(Feet)	(Feet)	(Feet Tons)	(Feet)	Foot Tons)	(Feet)	(Foot Tons)
100	18.6	181.3	—44.7	—831	371.3	6,906	Center of	
175	316.0	125.35	—25.65	—8,105	315.35	99,650	Gravity	
250	1637.0	88.58	12.58	12,593	278.58	456,035	Passes End	
325	3981.0	65.66	64.66	257,411	255.66	1,017,783	of Ways after	000.000
400	699.20	50.47	124.47	870,294	240.47	1,681,366	326′ 0″	
475	10437.0	41.63	190.63	1,989,605	231.63	2,417,522	Run	1,415,500

Midship section at Station No. 20, Frame No. 64½. Fore Poppet at Frame No. 17. Total launching weight = 9,500 tons., C. of G. at midship section. Moment of weight About Fore Poppet = 9500 × 190 = 1,805,000 foot tons.

to the launching weight minus the inclined displacement for any distance run.

The minimum vertical distance between the curves—i. e., the difference in foot-tons value—of moment of buoyancy about the end of the ways and moment of weight about the end of the ways, will be the least moment against tipping. This should be positive and ample to provide against a drop of tide due to unexpected delay in carrying out the launching operations. The value for the anti-tipping moment at low water or any intermediate tide may be ascertained as follows:

Since a drop in tide will make it necessary for the ship to run a greater distance to get the same buoyancy, move the moment of buoyancy about end of ways curve bodily aft a distance in feet $= \dfrac{\text{drop in tide}}{\text{slope}}$. Then raise all points on the curve an amount in foot-tons equivalent to the gain in moment due to the additional run. Run in launched on a lower tide, and the results as shown by the curves will not be exactly correct.

Determining Whether the Ship Will Drop When the Fore Poppet Reaches the End of the Groundways

Having drawn the forward end of the ship with the forward end of the fore poppet just at the end of the groundways, ascertain the height of water, w, above the end of groundways at the probable launching tide. Having calculated the probable trim of the vessel, with the forward and after drafts, the draft afloat, d, at the forward end of the fore poppet is determined by proportion.

The distance of the keel above the groundways is fixed, thereby limiting the draft which the forward end of the ship may gain prior to reaching the end of ways. Suppose the draft at the fore poppet on reaching the end of ways is D. If the distance D is $> d$, the ship will be afloat before the fore poppet reaches the end of the ways. If $D = d$, the ship will just float off the ways with no drop. If $D < d$, the ship must drop at this point by at least the amount of the difference $(d - D)$. Of course, if the ship does drop, the distance will be greater than $(d - D)$, due to the accumulated energy.

The matter of drop and the consequent increased momentary draft forward should be investigated, to the end that the channel between the ways may be free of obstructions to such a depth as will insure a safe launching.

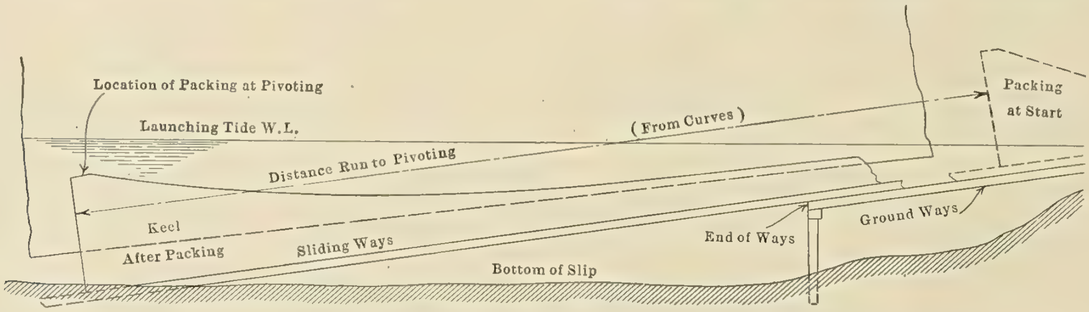

Fig. 6.—Diagram Showing Interference with Bottom of Slip before Pivoting Takes Place

the new curve. As before, the vertical distance between this curve and the moment of weight about the end of the ways will be the anti-tipping moment for the new tide.

In another article will be shown a method of obtaining quickly the anti-tipping moment for any tide and for any position of the center of gravity. Such a sheet is of value on the day of the launching, especially when the anti-tipping moment is known to be low.

As may be seen from an inspection of the curves, an increase in moment against tipping may be obtained by increasing the length of the groundways, or by increasing the declivity of the blocks or the ways.

Changing Declivity of Ways

Once the curves are obtained for one declivity of ways, they may be readily obtained for another declivity without repeating the operations outlined above. A greater declivity causes the same buoyancy to be obtained on a shorter run, while a less declivity requires a longer run. Therefore by altering the scale of the distance run in the ratio of the original to the new declivity the buoyancy and moment of buoyancy about the fore poppet may be read from the original curves. Knowing the point of intersection of the old and new ways, the new location of the end of the groundways which gives the desired depth of water over the end of ways is found. The new values of moment of weight and moment of buoyancy about the end of ways are then calculated, and these new curves laid off. Thus a complete set of curves for the new declivity are obtained.

It is well to note that when the launching slip is at all confined the effective height of tide will be lowered, due to water being swept out of the slip by the ship and cradle. The effect on the ship will be as though it was

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Salving the Sioux.—One of the most extraordinary mishaps that has occurred in Northern Pacific waters in many years was the recent grounding of the island passenger steamer *Sioux*, during a dense fog, upon the sandy beach of Dungeness Spit in the Strait of Juan de Fuca. Following the mishap tugs were dispatched to pull the *Sioux* off. The combined efforts of three tugs, however, were unavailing, and with each succeeding tide the *Sioux* was carried further up the beach, where the shifting sands held her hard and fast. After several days of unsuccessful effort with a tug, dredgers were obtained which were set to work on either side of the vessel. One dredge was of the clam-shell type and the other a suction machine. After working several days, these dredgers dug a deep channel under the *Sioux* and then she was hauled into deep water. Examination proved that the vessel had been undamaged by her enforced stay of six days on the sandy beach, and she soon returned to service. The *Sioux* is one of the fastest and best equipped passenger vessels on Puget Sound. She was built at Seattle two years ago, and, until the present mishap, has never had an accident of any kind. On anything but a sandy beach this mishap would probably have resulted disastrously. Not every vessel, however, can be "docked on the beach" without damage to her hull.

New French Battleships

Trials of the Paris and France—Launch of the Gascogne, Normandie and Flandre

Just before the outbreak of the war two powerful battleships of the *Dreadnought* class, the *Paris* and *France,* were delivered to the French Admiralty. The *Paris,* which was built by the Forges et Chantiers de la Mediterranée, at La Seyne, had just completed her full-power trials, while the *France,* which was built by the Chantiers de St. Nazaire (Penhoet), at St. Nazaire, had just returned from a voyage to Russia and Sweden with the President of the Republic on board. Although the *France* had had no time to carry out her full-power trials, nevertheless the return trip from the northern countries, which was made in haste, gave a splendid opportunity to test her seagoing and steaming qualities. For most of the voyage she averaged a speed of 19 knots.

The new battleships are 541 feet long between perpendiculars, 81 feet beam and at a draft of 30 feet with the extra bunkers filled and complete stores on board displace 25,850 tons. Propulsion is by Parsons turbines of 25,000 horsepower, designed to give the ships a speed of 20 knots.

On the three-hour full power forced draft trial, the turbines of the *Paris* developed over 35,600 horsepower, giving the ship a speed of 21.7 knots. On a ten-hour run under ordinary draft a speed of 21.15 knots was maintained. The coal consumption on these trials was much less than the contract figures called for, and on account of this the builders received a substantial bonus.

The armament consists of twelve 12-inch guns arranged in six turrets on the centerline of the ship, protected by armor 14 inches thick. There are twenty-two 5.5-inch rapid fire guns mounted in casemates and protected by 7-inch armor. The main armor belt is 12 inches thick, tapering to 7 inches at the ends.

Of the later French battleships, three of the *Normandie* class have already been launched, and while they will not be completed until 1916, they are of special interest because of the new features which have been incorporated in their design.

Fig. 1.—Battleship *France*—One of the Latest French Dreadnoughts

The Gascogne

The first of this class to be launched was the *Gascogne,* which was launched at the Lorient dockyard September 21, only eleven months after the keel was laid. Her launching weight amounted to 9,500 tons, and, owing to the narrowness of the river in front of the building slip, special arrangements were necessary to bring the vessel to rest after becoming water-borne. Although the vessel moved down the ways at a speed of 20 feet per second, no trouble was experienced in handling the vessel in the narrow river channel.

The *Gascogne* is 574 feet long overall, 88 feet 7 inches beam, and, at a draft of 29 feet with 900 tons of coal on board, she displaces 25,300 tons. Propulsion is by four screws, the wing shafts being driven by triple expansion engines which, at a speed of 115 revolutions per minute, develop 17,500 indicated horsepower (including auxiliaries). The reciprocating engines alone are capable of giving the ship a speed up to 16 knots, but above that the power is augmented by Rateau turbines mounted on the inner shafts. The turbines are capable of developing 16,000 horsepower.

Steam is furnished by twenty-one small-tube boilers of the Guyot-Du Temple patent watertube type, working at 285 pounds pressure. The boilers have a heating surface of 74,000 square feet and are fitted for burning either coal or coal and liquid fuel combined. Nearly all of the auxiliaries are driven by electric power, the electric plant consisting of four turbine-driven generators of 400 kilowatts capacity.

The lines of the hull have been very carefully designed and with a freeboard of 25 feet forward it is expected that the vessel will be able to maintain her speed in a rough sea. Numerous watertight compartments have been worked between the two protective decks, none of these compartments communicating with the bottom of the ship.

Armor and Armament

The main armor belt is 15 feet wide, extending 8 feet above the load waterline. The thickness varies from 12 inches amidships to 7 inches at the ends. Above the main armor belt is a central citadel over 370 feet long, protected by 7-inch armor and connected to the turrets amidships by athwartship bulkheads of the same thickness. Above the citadel for a length of 200 feet amidships there is a 6-inch armor protection behind which is mounted the secondary armament.

Special care has been given to the protection of the ship against torpedo attack, and extra longitudinal bulkheads have been worked for nearly the whole length of the ship under the protective deck. These bulkheads consist of three plates, each over ⅜-inch thick, mounted on steel angle bars, the outer plate being offset. This design, while novel, has been proved by experiments carried out at Lorient very efficient as a means for resisting torpedo attack.

The main armament consists of twelve 13-inch guns located in turrets all on the centerline. The turrets are protected by 15-inch armor and each turret is divided into two compartments by an 11-inch armor bulkhead. The forward and after turrets have a range of fire of 280 degrees, while the central turret has a range of fire of 300 degrees. Each turret weighs over 2,000 tons. The secondary armament consists of twenty-four 5.5-inch rapid fire guns and six 18-inch submerged torpedo tubes.

Fig. 2.—Battleship *Paris*, Sister Ship of the *France*

Among other new features which have been worked into the design of the *Gascogne* is the arrangement of the conning tower, which is of large size and divided into three separate compartments, the first and second being devoted to the navigation of the ship and squadron, and the third to the officer in charge of the guns. It is officially stated that the conning tower will be protected by 12-inch armor, but it may be confidently expected that the thickness of the armor will be increased. It is worthy of note that the forward turret wil also contain duplicates of the apparatus in the conning tower, so that it may be used as a secondary conning tower in case of need.

Launch of the Normandie

Since the launching of the *Gascogne* two other battleships of the same class, the *Normandie* and *Flandre*, have been launched. The *Normandie* is being built by the Ateliers et Chantiers de la Loire, of St. Nazaire, and the

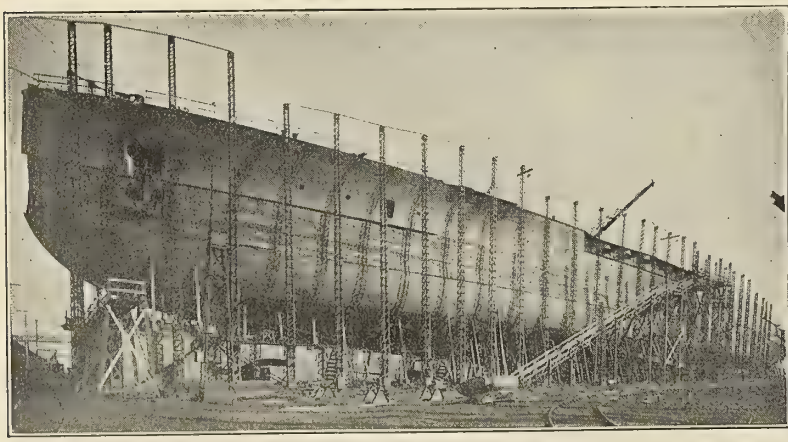


Fig. 3.—The *Normandie* before Launching

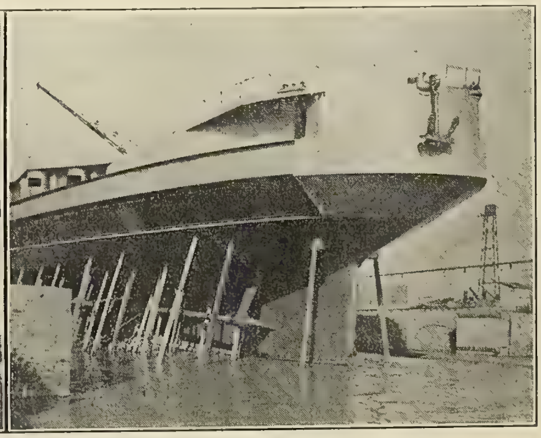


Fig. 4.—Stern of the *Normandie*

Flandre at the Brest dockyard. The keel of the *Normandie* was laid September 10, 1913, and that of the *Flandre* October 9, 1913.

The launching weight of the *Normandie*, including the cradle, was 9,257 tons, representing a pressure of 4.55 tons

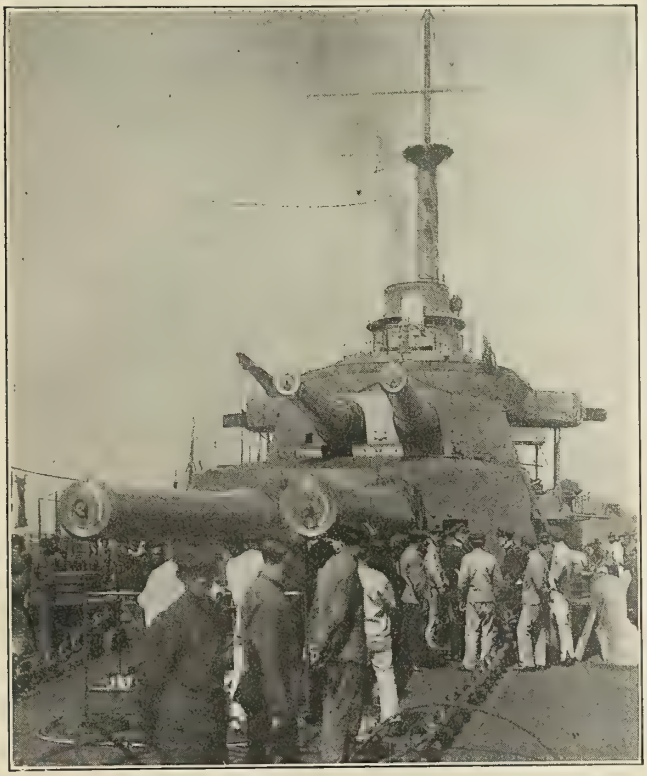


Fig. 5.—Forward Turrets of the *France*

per square foot on the sliding ways, which were 519 feet long and 48 inches wide, with a declivity of 6 percent. The vessel went down the ways at a speed of 18 feet per second.

Bids for New United States Destroyers

Bids for the six new torpedo boat destroyers authorized by the last Congress were opened on Nevember 10 at the Navy Department, Washington, D. C. According to the privileges granted under the policy of the Navy Department, two classes of bids were submitted: Class I provided for the construction of hull and machinery in accordance with the Department's plans and specifications, and Class 2 provided for both hull and equipment in accordance with the Department's plans, while the machinery was in accordance with the contractor's plans and specifications.

Seven bids were received, one of which was from the Mare Island Navy Yard, California, and the other six from private yards on the Atlantic and Pacific coasts.

The lowest bid was submitted by the Fore River Shipbuilding Corporation, Quincy, Mass., which offered to build two vessels, Class 2, for $795,000 (£163,000) each, to be completed within from twenty-three to twenty-four months and to have a speed of 29½ knots. The bid submitted by the Fore River Company under Class 1 was $852,000 (£175,000) for each ship.

William Cramp & Sons Ship & Engine Building Company, Philadelphia, Pa., proposed to build three vessels, Class 1, for $834,000 (£171,000) each, and Class 2 for $825,000 (£169,000) each, to be completed in twenty to twenty-two months and of 29½ knots speed. The Bath Iron Works, Bath, Me., proposed to build two or three vessels, Class 2, for $850,000 (£174,000) each, to be completed in from twenty-three to twenty-four months; speed, 30 knots.

The Union Iron Works, San Francisco, Cal., submitted bids under Class 1 to build each vessel at $880,000 (£180,000). The Newport News Shipbuilding & Dry Dock Company, Newport News. Va., submitted a bid under Class 2 with Parsons turbines to build two vessels of 29½ knots' speed in twenty-three to twenty-four months at $885,000 (£181,500) each, and with Curtis turbines $875,000 (£179,000) each. The Seattle Construction & Dry Dock Company offered to build two boats for $860,000 (£176,000) each.

At the present time the destroyers in question are officially designated Nos. 63-68, inclusive. They are of a type larger than any ship of the destroyer class so far constructed for the United States Navy, and will have a minimum speed of 29½ knots when running under full power conditions. In general features the new destroyers are similar to those recently built, except for increased displacement (1,100 tons as compared with 1,090 tons for the previous class) and the placing of additional torpedo tubes and guns. The armament consists of four sets of 6.8 by 21-inch triple torpedo tubes, two 4-inch rapid fire guns and two 4-inch aero guns, the latter arranged one forward and one aft.

The engine space is divided into two compartments, the forward compartment containing the main propelling machinery and the after compartment the auxiliaries. There are two boiler compartments, each containing two boilers equipped for burning oil fuel only. Each boiler has its own smokestack. The propelling machinery consists of main ahead and astern turbines driving two shafts.

The main particulars of the new destroyers are given below:

Displacement, tons	1,100
Turbine arrangement	twin screw
Shaft horsepower	17,000
Revolutions per minute of main turbines	450
Steam pressure at turbines, pounds gage	250
Cooling surface, condensers, square feet	11,600
Number of boilers	4
Steam pressure at boilers, pounds gage	265
Total heating surface, main boilers, square feet	21,500
Speed, knots	21.5

CUNARD LINER TRANSYLVANIA.—The new Cunard liner *Transylvania*, which recently made her maiden voyage across the Atlantic, marks a step in the adoption of geared turbines for ship propulsion. She is the first large transatlantic liner to be fitted with this type of machinery. The turbines are of the Parsons type, driving twin screws through gear wheels about 10 feet in diameter and 5 feet in breadth. Each shaft is driven by two turbines working in series and operating at about 1,500 revolutions per minute. An astern turbine of the impulse reaction type is incorporated with each low-pressure ahead turbine. The arrangements are such that either the high-pressure turbine or the low-pressure turbine can be used independently, so that any mishap to one turbine will not prevent the vessel from proceeding with both propellers in operation. A complete system of forced lubrication is installed for all turbine and gear wheel bearings. The boiler installation consists of six large double-ended Scotch boilers working under natural draft at a pressure of 210 pounds per square inch. The boilers are arranged in two groups of three each in separate boiler rooms. The vessel is 567 feet long, 66 feet 6 inches beam, 45 feet depth, with a gross tonnage of 14,500 and a displacement of 20,000 tons.

Repairs to Lake Freighter H. M. Hanna, Jr.

During the disastrous storm on the Great Lakes last November, the freight steamer *Howard M. Hanna, Jr.*, bound from Lorain, Ohio, to Fort William, Ontario, with a cargo of about 9,100 tons of coal, was wrecked on the Port Austin Reef in Lake Huron. Although the vessel was practically broken in two at the after end of No. 7 hatch from the top sides down to the top of the side tanks, which form the hopper bottom of the vessel, and her superstructure and hatches were practically demolished, nevertheless the machinery of the vessel was only slightly damaged. She was salved by the Reid Wrecking Company, of Sarnia, and, after her coal cargo was discharged at Port Huron, patches were put on the cracks on the deck and sides of the ship and she was brought to the Collingwood Shipbuilding Company, Ltd., Collingwood, Ontario, under her own steam for repairs.

As can be seen from the illustrations, the break at the after end of hatch No. 7 was of a very clean character, the fracture passing through the solid shell plating instead of through any of the rows of rivets in either the frames or butts. It is practically certain that the vessel would have broken completely in two if it were not for the hopper construction of the hull, as the fracture extended only from the top sides down to the top of the wing tanks, which form the hopper hold construction.

Fig. 2.—After Deck House Demolished

When the vessel arrived in Collingwood she was placed in the dock for a preliminary examination. It was found that for about 150 feet amidships the bottom was up about 4 feet. Under No. 1 hold the bottom was also up about 1 foot, and just forward of the boiler room a similar state of affairs prevailed. In fact, there were only one or two portions of the entire 480 feet length of the ship that were straight. The vessel was also hogged over 2 feet in the center, and, in order to straighten her out and bring her back to her normal sheer, she was undocked and special cribs were built at the forward and after ends of the vessel, after which she was docked again.

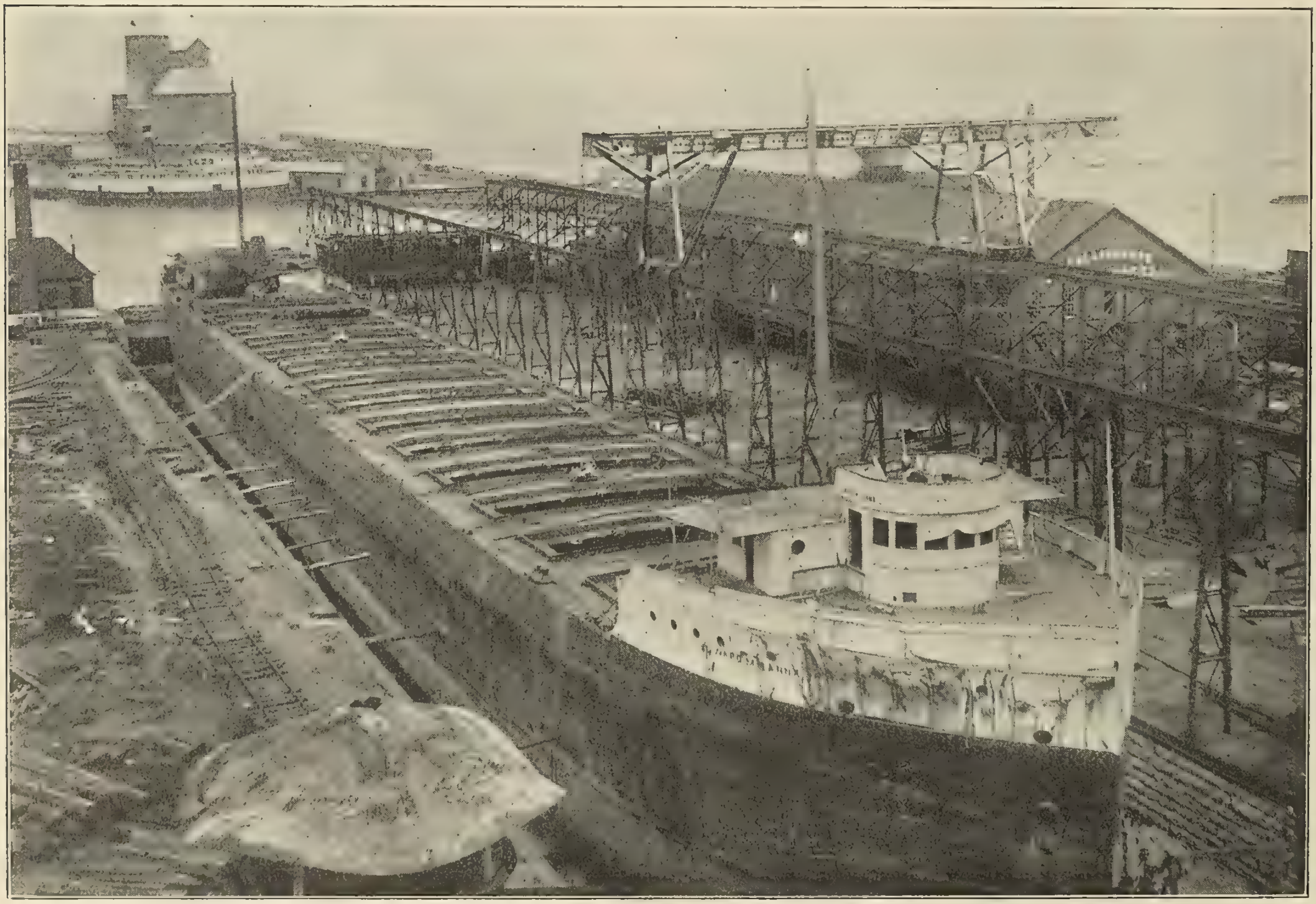


Fig. 1.—Battered Hull of the *Howard M. Hanna, Jr.*, in Dry Dock at Collingwood, August 27

Fig. 3.—Fracture in Shell Plating (Port Side)

Fig. 4.—Fracture in Shell Plating (Starboard Side)

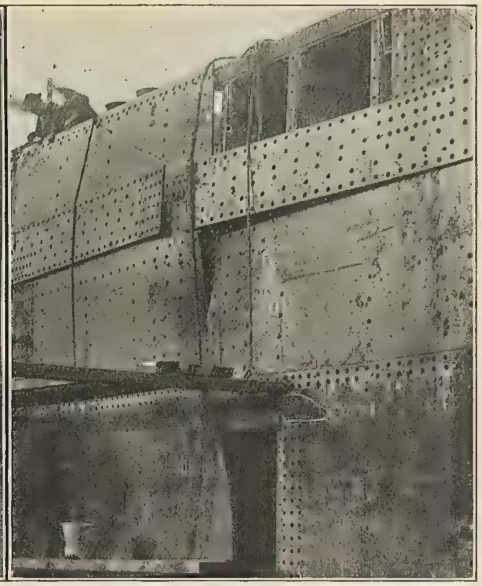


Fig. 5.—Removing the Fractured Plates

Sufficient water was pumped out to settle the vessel on the blocks at the ends, and then work was started cutting out the damaged portions of the shell plating and tank plating, and also the side tanks and stringers. As the cutting proceeded, the water was gradually lowered in the dock, and the vessel allowed to come down. The sheer heights of the spar deck had been obtained from the builders of the ship, and sights were arranged on the deck, so as to tell exactly when the vessel had settled the proper amount. As soon as the normal sheer was reached, the dock pump was stopped and the vessel was securely shored amidships to prevent her from settling any further.

After the dock was pumped out the cutting out of the tank top and bottom plating was begun. Apart from the damage to the bottom, the vessel was very severely punished both before and after going on the rocks. The steel covers over the hatches were badly torn and most of them had been driven into the hold. The 12-inch channel hatch coamings were also badly twisted by the waves coming aboard on the starboard quarter. The forecastle side plating was stove in, as shown in Fig. 1, and considerable damage was done to the pilot house. The after deck house and casing was of very light scantlings, and, together with the smokestack, was easily torn away in the storm, as shown by Fig. 2. Little damage was done to the boilers and propelling machinery, although the propeller itself was damaged by the rocks and the shoe and rudder had carried away.

One of the most remarkable features of the damage

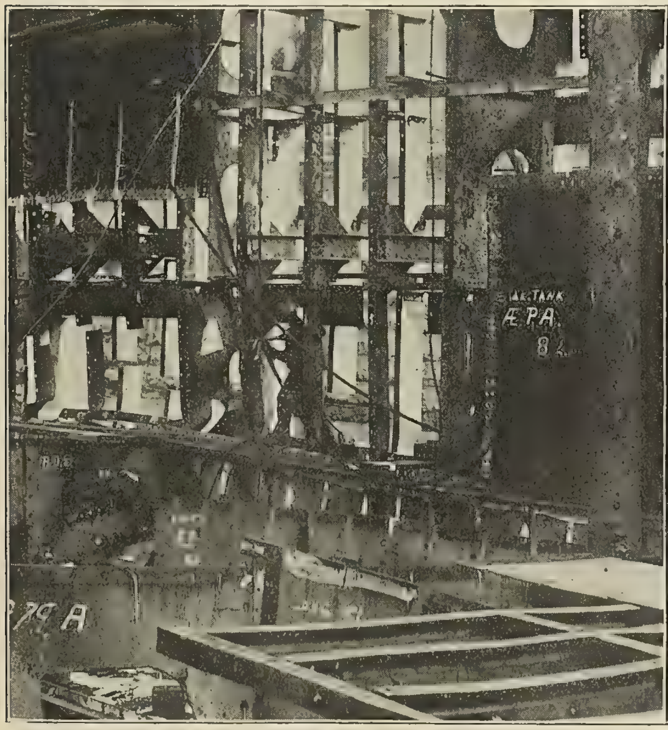


Fig. 6.—Interior View (Port Side)

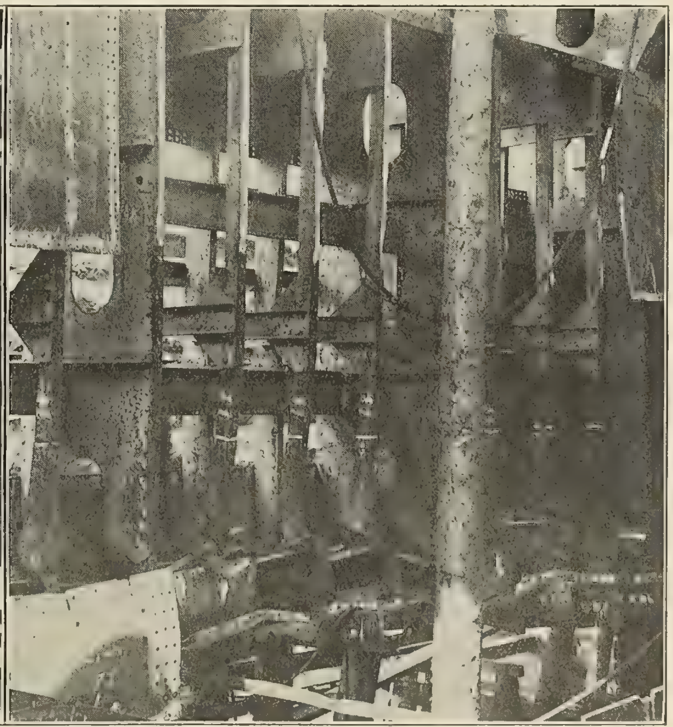


Fig. 7.—Interior View (Starboard Side)

done to this vessel is the fact that, although the bottom below the tank top, including the floor plates, was twisted out of shape so that the bilge projected out beyond the side of the vessel for a distance of 16 to 18 inches, nevertheless not one of the plates was broken and apparently not a single rivet had sheared or started. This speaks well for the quality of the material and the workmanship in the vessel, and it also shows the strength of the hopper form of construction, for without this the vessel would undoubtedly have been broken completely in two and become a total loss, as was the case with many of the lake vessels in same storm. The unexpected severity of the storm that wrecked the *Howard M. Hanna, Jr.*, however, was something that is very likely to be repeated, and the designers of large lake freighters should bear these conditions in mind.

The White Star Liner Britannic

Main Particulars of the Latest White Star Liner—Details of the Machinery and the Passenger Accommodations

In spite of the war, active construction work continues at the Harland & Wolff shipyard, Belfast, on the 50,000-ton steamship *Britannic,* which the White Star Line expects to place in service in 1915. The vessel was launched February 26, 1914. Her principal dimensions are as follows:

Length overall, about	900 feet
Breadth, extreme, about	94 feet
Depth, molded	64 feet 3 inches
Total height from keel to navigating bridge,	104 feet 6 inches
Gross tonnage, about	50,000 tons
Load draft	34 feet 7 inches
Displacement at load draft, over	53,000 tons
Indicated horsepower of reciprocating engines,	32,000 tons
Shaft horsepower of low-pressure turbine	18,000
Service speed	21 knots
Number of decks	9
Passenger accommodations:	
First class	790
Second class	836
Third class	953
Total passengers	2,579
Crew	950
Total	3,529

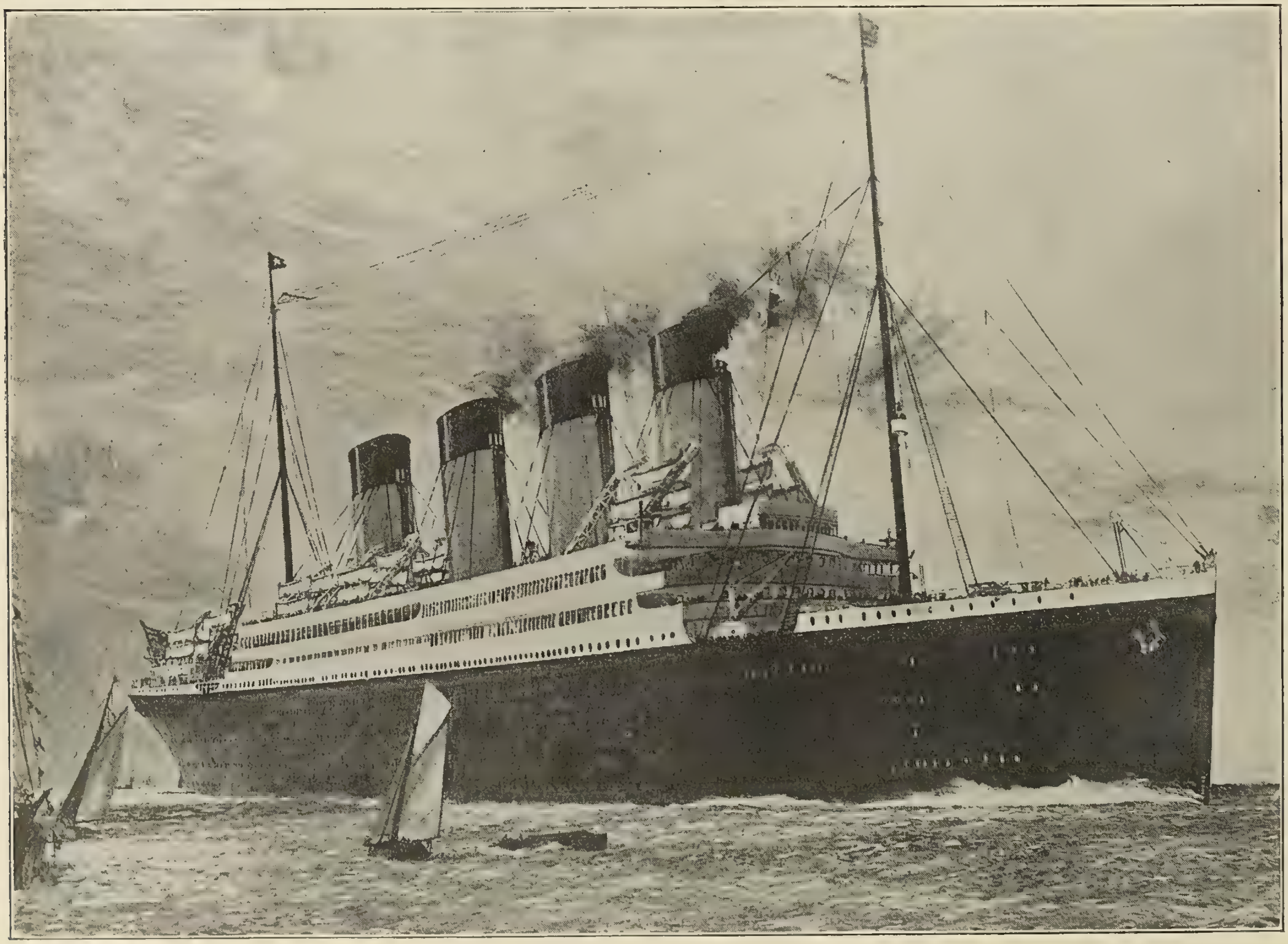


Fig. 1.—Sketch of the *Britannic*, as She Will Appear When Completed, Made from the Builders' Plans

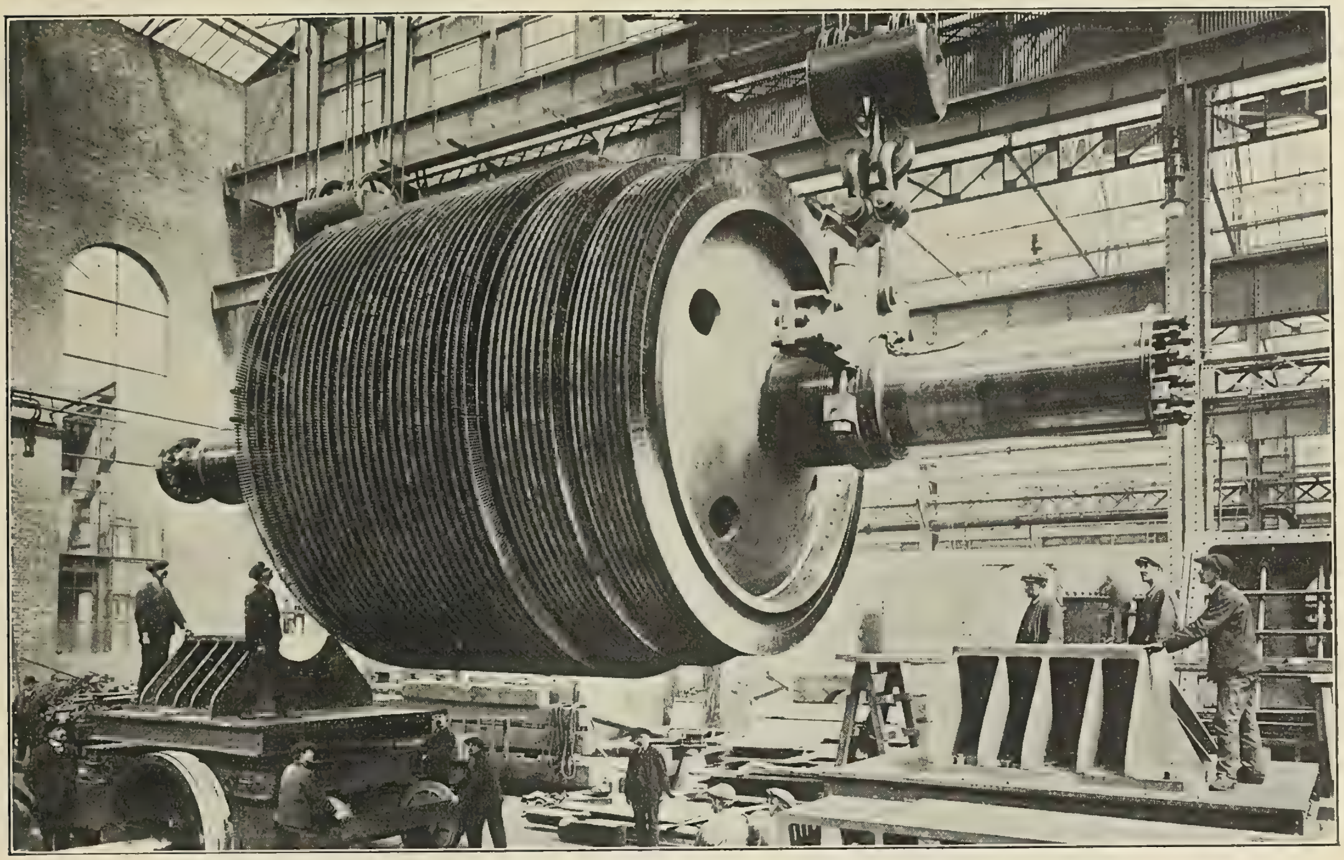


Fig. 2.—Rotor of the Low-Pressure Turbine. Weight, 152 Tons

Fig. 3.—Turbine Assembled in the Builders' Shops. Weight about 420 Tons

The immense size of this new leviathan is better appreciated by reference to the previous ships brought out by the White Star Line during the last fifteen years. In the *Oceanic*, which was completed in 1899, the length was 685 feet and the displacement 31,600 tons at 35 feet 7 inches draft. The *Cedric*, built in 1903, had a length slightly less, but, owing to her greater beam, an increased displacement of 37,900 tons on a draft of 36 feet 8 inches. The *Baltic* of the following year had a length of 708 feet and a displacement of 40,700 tons on a draft of 37 feet 3 inches. The *Adriatic*, completed in 1906, was the next notable ship, and in her case the length was over 725 feet and the displacement 40,800 tons. The *Olympic*, completed in 1911, marked a still further increase in length to 882 feet 9 inches with a displacement of 50,000 tons on 34 feet 6 inches draft. Compared with the foregoing, the *Britannic*, with slightly increased beam resulting in a displacement of over 53,000 tons on a draft of 34 feet 7 inches, marks a logical advance in size of the White Star ships thoroughly in keeping with the policy of the company, which has been closely adhered to ever since the White Star Line became one of the foremost transatlantic steamship companies.

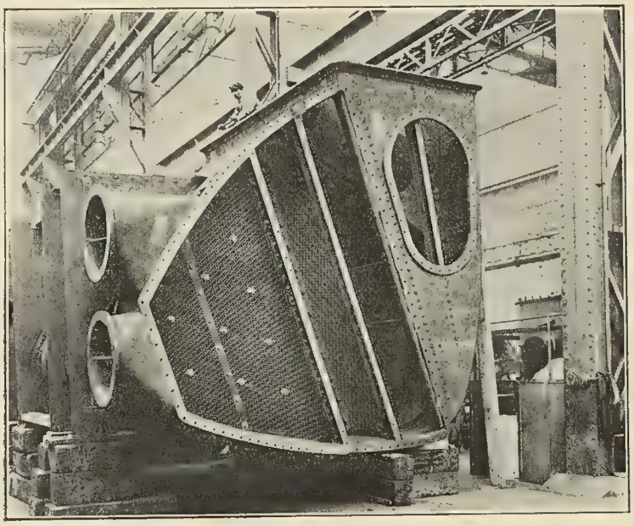


Fig. 4.—Condenser

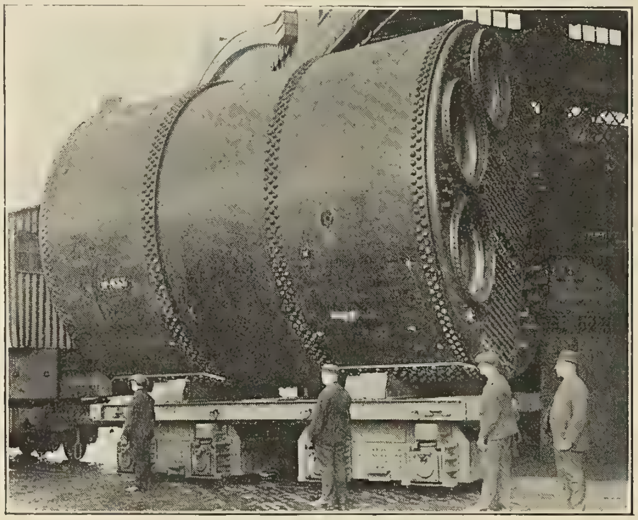


Fig. 7.—One of the Double-Ended Boilers

Special interest in the construction of the *Britannic*, however, centers in the machinery. Propulsion is by three screws, the wing screws being actuated by four cylinder triple expansion engines with cylinders 54, 84, 97 and 97 inches diameter and 75 inches stroke located in one engine room with the usual feed, sanitary and bilge pumps and all auxiliaries associated with the boiler feed and the refrigerating machinery in the same compartment. The center screw is driven by a low-pressure Parsons turbine about 50 feet long, which weighs complete 490 tons and operates at full power at 170 revolutions per

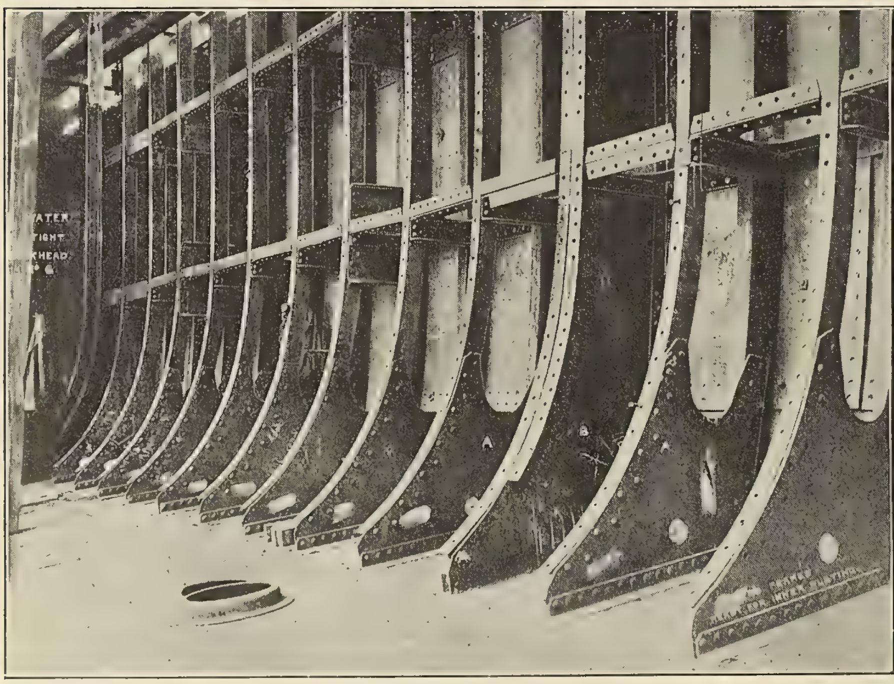


Fig. 5.—Framing for Inner Shell

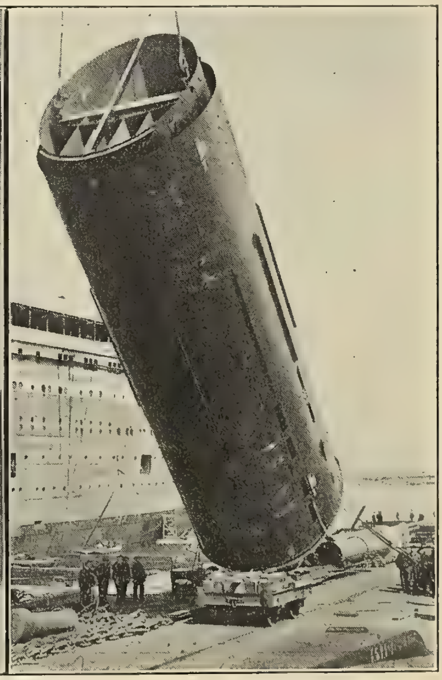


Fig. 6.—Smokestack

minute, taking exhaust steam from the reciprocating engines at about 9 pounds pressure absolute and exhausting into two condensers at about 1 pound absolute. When running at 165 revolutions per minute, the turbine will develop more than 16,000 horsepower. The turbine is used only for ahead propulsion, the backing and maneuvering being taken care of by the reciprocating engines.

Fig. 2 shows the rotor of the turbine, which, apart from the casing, weighs 152 tons. Its exact dimensions are: Length, 49 feet, and diameter 16 feet 11 inches. It is among the largest and most powerful ever constructed for marine service. The blading is of the regular Parsons laced type, with the distance pieces at the roots and binding soldered on the edge. The blades range in length from 18 inches to 25½ inches. Fig. 3 shows the complete turbine with casing assembled. Its weight is about 420 tons.

Steam is supplied by twenty-four double-ended and five single-ended boilers arranged in six boiler rooms. The boilers are all 15 feet 9 inches mean diameter. The double-ended boilers are 21 feet mean length and the single-ended boilers 11 feet 9 inches mean length. The heating surface of each double-ended boiler is 5,702 square feet and the grate area 130.8 square feet, while in the single-ended boilers the heating surface of each is 2,822 square feet and the grate area 65.4 square feet.

There are in all four funnels of elliptical section with a major diameter of 24 feet 6 inches and a minor diameter of 19 feet 10 inches. The total height of the funnels above the grates is 150 feet. About twenty uptake branches lead to each funnel.

On six of the nine decks in the ship accommodations are provided for about 2,600 passengers. The first class accommodations are amidships and the second class immediately abaft the first class quarters. On the bridge deck, the first deck immediately below the boat deck, are a large gymnasium, a children's play-room and an à la carte restaurant extending the full width of the ship. On the promenade deck immediately below are the public rooms, including a reading and writing room, a first class lounge and a first class smoking room with veranda café and palm court. The shelter deck is given over almost entirely to first class staterooms, while on the deck below is the main dining-room and a reception room in connection with it. Three electric elevators extend through the first class quarters clear up to the boat deck, while further aft is another first class elevator extending up to the boat deck.

In the second class accommodations, the dining saloon is on the saloon deck, the library, reading room and second class gymnasium on the shelter deck, while the smoking room is on the bridge deck with a large space for promenade. The third class public rooms are in the stern of the ship with the exception of the dining saloon, which occupies a space of two watertight compartments on a lower deck amidships.

The sanitary arrangements, heating and ventilating systems and the electric plant embody the latest features which have been developed for marine work. The lifesaving apparatus includes forty-eight of the largest size lifeboats yet made, two of which are fitted with motors for propulsion.

An entirely new type of davit is used for handling the boats. There are two sets of davits on each side of the boat deck, of lattice girder construction pivoted at their ends and actuated from a vertical position to a considerable angle either inboard or outboard by means of an electric motor-driven screw gear. The height and outreach of the davits enable the boats to be mounted one over the other in tiers and also facilitate the placing of several tiers in the width of the ship. This type of davit permits stowing the lifeboats a sufficient distance inboard to give a wide passage along the deck for promenading and for grouping the passengers in case of emergency. Special devices are fitted to arrest the motion of the davits or boats in case of a mistake on the part of the operator, and powerful electric lamps are provided at the top of each davit to facilitate the operation of the gear at night. Means are also provided for lowering the boats on an even keel, irrespective of the trim of the vessel.

Fig 1.—Steam Collier *Edward Peirce* before Launching at Newport News

Steamship Edward Peirce

The sailing of the steamship *Edward Peirce* from the yard of her builders, the Newport News Shipbuilding & Dry Dock Company, adds another "made in America" unit to the not overcrowded merchant marine of the United States. This is the third steamer for the Crowell & Thurlow Steamship Company, of Boston, Mass., built at Newport News, as the *Peter H. Crowell* and *Lewis K. Thurlow* are the products of the same yard.

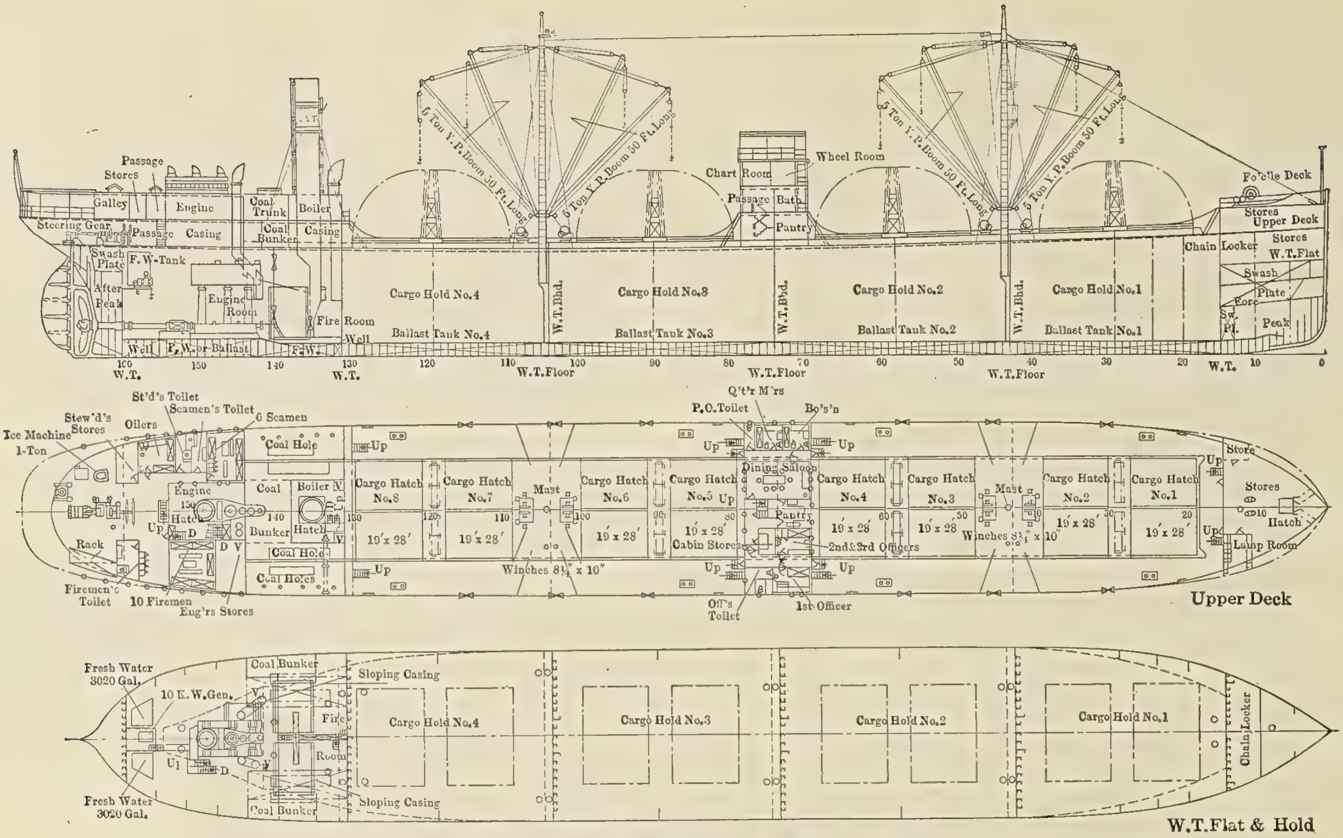


Fig. 2.—Profile and Deck Plans of the *Edward Peirce*

The *Edward Peirce*, while designed primarily for a collier, is fitted with cargo handling gear, cargo battens, etc., so that her usefulness is not confined to carrying coal. The vessel will make a successful carrier for any kind of bulk cargo, lumber or general cargo.

The dimensions are as follows: Length overall, 375 feet; length Lloyds', 360 feet; beam, molded, 49 feet; depth, molded, 30 feet; deadweight at 23 feet draft, 6,500 tons; sea speed, loaded, 10 knots; gross tonnage, 4,387; net tonnage, 3,228.

The vessel is a single screw steamer with two masts and machinery aft. The accommodations for the deck officers are in a short bridge amidships. The crew and engineers are accommodated under the poop deck and in a deck house on the poop deck. The galley, refrigerating rooms and refrigerating machinery are aft, and there is a direct connected steam steering gear, with telemotor control from the pilot house. A continuous trunk for the extent of the hatch openings permits the decks to be raised between hatches, simplifying drainage and gaining in cubic capacity. There are eight hatches 19 feet by 28 feet, fitted with steel hatch covers and rubber gaskets.

The propelling machinery consists of a triple expansion engine with cylinders 23 inches by 39 inches by 66 inches diameter by 45-inch stroke, a main and auxiliary condenser, an air pump of the Edwards type, a centrifugal circulating pump, two attached feed pumps, two attached bilge pumps, a fire and donkey pump, ballast pump, one 20-ton evaporator, a Reilly feed water heater and Ebson filter. The boilers are of the single-ended Scotch type, 15 feet diameter, 11 feet 6 inches long, with three 45-inch Morison furnaces and separate combustion chambers. They are designed for heated forced draft, and a working pressure of 180 pounds of steam.

The keel of this vessel was laid June 17, and the vessel was launched October 24, with engines aboard, stack up, boilers tested and ready for steam. The dock trial was held on November 2, and the vessel was delivered to its owners on November 6, 1914. The general arrangement of the vessel is illustrated in the accompanying plans.

Progress of U. S. Naval Vessels

The Bureau of Construction and Repair, Navy Department, reports the following percentage of completion of vessels for the United States navy:

BATTLESHIPS

	Tons.	Knots.		Aug. 1.	Nov. 1.
Nevada	28,000	20½	Fore River Shipbuilding Co.	72.4	77.8
Oklahoma	28,000	20½	New York Shipbuilding Co.	72.6	79.3
Pennsylvania	31,400	21	Newport News Shipbuilding	42.0	58.3
Arizona	31,400	21	Navy Yard, New York	24.4	36.8

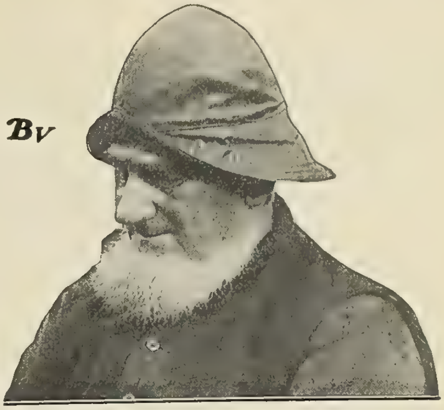
TORPEDO BOAT DESTROYERS

Downes	1,010	29	New York Shipbuilding Co.	95.3	95.3
O'Brien	1,050	29	Wm. Cramp & Sons	79.0	88.4
Nicholson	1,050	29	Wm. Cramp & Sons	73.3	86.5
Winslow	1,050	29	Wm. Cramp & Sons	71.5	82.3
Cushing	1,050	29	Fore River Shipbuilding Co.	56.1	73.7
Ericsson	1,050	29	New York Shipbuilding Co.	76.9	87.4
Tucker	1,090	29½	Fore River Shipbuilding Co.	12.6	18.8
Conyngham	1,090	29½	Wm. Cramp & Sons	11.1	39.5
Porter	1,090	29½	Wm. Cramp & Sons	9.0	29.5
Wadsworth	1,090	29½	Bath Iron Works	48.4	66.4
Jacob Jones	1,090	29½	New York Shipbuilding Co.	14.9	33.7
Wainwright	1,090	29½	New York Shipbuilding Co.	14.4	33.4

SUBMARINE TORPEDO BOATS

G-4	....	....	Wm. Cramp & Sons	96.4	100.0
G-2	....	....	Newport News Shipb'g Co.	89.7	89.7
G-3	....	....	Lake T. B. Co.	82.3	85.7
K-3	....	....	Union Iron Works	98.1	100.0
K-4	....	....	Seattle Con. & D. D. Co.	98.8	100.0
K-5	....	....	Fore River Shipbuilding Co.	98.8	100.0
K-6	....	....	Fore River Shipbuilding Co.	98.8	100.0
K-7	....	....	Union Iron Works	94.3	98.1
K-8	....	....	Union Iron Works	94.3	98.1
L-1	....	....	Fore River Shipbuilding Co.	49.3	67.4
L-2	....	....	Fore River Shipbuilding Co.	48.2	66.2
L-3	....	....	Fore River Shipbuilding Co.	47.3	66.1
L-4	....	....	Fore River Shipbuilding Co.	46.6	65.7
L-5	....	....	Lake T. B. Co.	28.9	41.2
L-6	....	....	Lake T. B. Co. (Long Beach, Cal.)	28.1	41.7
L-7	....	....	Lake T. B. Co. (Long Beach, Cal.)	26.6	39.7
M-1	....	....	Fore River Shipbuilding Co.	33.1	50.6
L-8	....	....	Navy Yard, P'tsmouth, N. H.	0.0	0.0
L-9	....	....	Fore River Shipbuilding Co.	12.3	24.9
L-10	....	....	Fore River Shipbuildiing Co.	12.3	23.8
L-11	....	....	Fore River Shipbuilding Co.	11.2	0.0

Economy Talks By "Old Scotch"



Clean Boilers and Tight Joints Another Source of Economy

Well boys, we must continue our chase for that saving I have been telling you about. Of course, the greatest saving, as I said before, is in burning the fuel properly, but we can save a whole lot by being clean.

By that I don't mean that any of you need a bath, for I would be the first one to be insulted if any one insinuated that marine engineers didn't bathe often enough. If I do say it myself, we are the cleanest people on earth, personally—but some of us are not so clean when we come to the iron workmen that we run and look after. A man may go around dirty and lose nothing but his self-respect, but if we let our boilers go dirty we are losing coal—and coal is money. Some old philosopher said that cleanliness is next to godliness, and that's the reason washday comes on Monday. So it is with us marine engineers, the next most important thing to saying our prayers is to keep our boilers clean.

I mean just what I say about "keeping them clean." That doesn't mean altogether that we should clean them after they get good and dirty, but that we should start in with them clean, and try to "keep them clean." The main business of a marine boiler is to transmit the heat from the furnaces and tubes through the metal into the water and turn it into steam. Steel and iron, with clean surfaces, just dote on passing heat units right on through from the fire-side to the water-side. If, on the water-side, we allow scale and dirt to collect, then there is a strike in the transmitting apparatus right off. For every 1/16 of an inch of scale or dirt formed on the water-side of the heating surfaces, it is "good-night" to about 10 percent of your heat transmission. If you're burning fifty tons of coal a day under ordinary circumstances to make the required speed, then when this scale gets busy blocking the heat units, you may just as well prepare to burn up fifty-five tons of coal per day to accomplish the same work. It's all right to put non-conducting material on the outside of the boiler, but don't ever let it get on the inside. I've seen some old boilers so badly scaled up that I really believe they would have worked better if they had been turned inside out.

It's just about as bad for economy if you allow the soot to collect on the fire surfaces of your flues and tubes. Soot isn't much better as a conductor or transmitter of heat units than boiler scale, so you can see that it is a case of the Lord help any poor boiler which suffers from both scale and soot, and I want to tell you right here that there are plenty of boilers running right now which have both afflictions. You might just as well try to get a good day's work out of a laborer who is suffering from stomach-ache and rheumatism at one and the same time.

The stomach-ache and boiler-scale are something alike, as they both can be cured by a liberal use of good, old-fashioned soda. I can't say that there is any similar remedy for both soot and rheumatism. Soot can be gotten rid of with brushes and elbow-grease, but I haven't heard of anything yet that will take this rheumatism out of my right shoulder, when it gets to going good and strong.

There are other things around a fireroom which cause waste besides scale and soot. They say that money is the root of all evil, and procrastination is the thief of time. I'm not sure about the money proposition, but I do know that procrastination, or "putting off," whichever label you choose to put on it, is somewhat of a thief of heat units, when it comes to pulling off the stopping of leaks around a boiler or the making of new joints in the steam pipes, and boiler connections. If I go into a fireroom and hear a lot of hissing like a den of sarpints, I always think of the good money that is being wasted, and of how lazy the chief engineer must be to let steam or hot water escape that way. A half dozens leaks around a fireroom which make noise enough to be heard plainly are about equal to the waste of a ton of coal a day on an average-sized steamer. The only noises that ought to be heard around a well-managed fireroom are the sounds of the shovel, the roar of the draft and the lullaby of the water tender as he jumps on a fireman for keeping the furnace-doors open too long.

Of course, every leak in a steam joint is not due to laziness, as many of them come from using bum packing, where only the best material should have been used. If the engineer is supplied with cheap packing, that is, the kind composed of 2 percent rubber, 4 percent fiber and 94 percent of baked mud, he can't be expected to keep steam joints tight. The company saves a dollar and a half in gaskets and loses a couple of hundred dollars in coal by buying that kind of material.

While I am strong for economy in every legitimate way, it has been my experience for many years' standing—or, I might say, running—that you never save anything around marine machinery by using cheap materials. The best is none too good on board steamships. When you are out at sea, you're a long ways from a safe place, and the lives of all on board, as well as the ship and cargo, depend upon everything around the machinery ringing true. It's no place for bad coal, bad oil, bad packing, bad tools, or, in fact, for anything which only has cheapness to recommend it. Whenever a man tries to sell me anything for use on my job and dwells stronger on its cheapness than on its good quality, he not only doesn't make any sales, but he is told to go where there is plenty of heat, but no steam pipes to leak.

Yours for economy,

Old Scotch

Questions and Answers for Marine Engineers

Inquiries of General Interest Regarding Marine Engineering and Shipbuilding will be Answered in this Department

CONDUCTED BY H. A. EVERETT *

This department is maintained for the service of practical marine engineers, draftsmen and shipbuilders. All inquiries should bear the name and address of the writer. Anonymous communications will not be considered. The identity of the writer, however, will not be disclosed unless the editor is given permission to do so. Indicator cards taken from marine engines will be carefully analyzed, the defects pointed out, and the horsepower calculated, provided complete data are sent with the cards.

Q.—How thick should the fires be kept for good combustion and economical operation? S. M.

A.—For good non-caking coal and natural draft about 6 inches, for caking coal about 8 inches, and for forced draft sometimes as thick as 12 inches are good practice.

Q.—Which is the correct way to run oil grooves in the crosshead, crank and main bearing brasses of a marine engine to secure best results? C. M. C.

A.—Oilways should be cut so that the oil is brought to the point of greatest pressure, and also is forced to distribute itself evenly over the face of the bearing, but they should not be cut so that the oil tends to run out at the end of the journal. The figure-of-eight groove is generally the most satisfactory for small bearings. Oilways should not be cut in line with the greatest stress in a bearing, as they then weaken the white metal at the point where it most needs strength.

Q.—Please give a formula for the calculation of flat surfaces. First, for the shell of an oval condenser; second, for flat valve chest covers. Will you also kindly give the width at the outer and inner rims of an impeller 28 inches diameter, number of revolutions 410; suction diameter, 16 inches; circulating pump to deliver 7,500 gallons of water per minute; head of water, 15 feet. L. S.

A.—The theory of elasticity gives us a method of *readily* calculating *two* sorts of flat surfaces subjected to uniform pressure and by involved and complex calculations the solution of several others. The two cases which permit of ready solutions are:

First, flat circular plates either supported or fixed at the edges (Figs. 1 and 2), and second, flat plates supported at regular intervals by stays as the sides of a locomotive firebox (Fig. 3).

For circular plates

$$t = r\sqrt{\frac{5p}{6f}} \text{ when supported at edges.}$$

$$t = r\sqrt{\frac{2p}{3f}} \text{ when fixed at edges.}$$

t = thickness in inches.
r = radius of plate in inches.
p = pressure pounds per square inch.
f = fiber stress per square inch.

If an allowable working strength be used of 2,500 pounds for cast iron, 6,000 pounds for wrought iron, and 10,000 for steel, the above formulæ become

	Supported	Fixed
Cast iron	$t = .0183\, r\sqrt{p}$	$t = .0163\, r\sqrt{p}$
Wrought iron	$t = .0118\, r\sqrt{p}$	$t = .0105\, r\sqrt{p}$
Steel	$t = .0091\, r\sqrt{p}$	$t = .0082\, r\sqrt{p}$

For a flat plate supported at regular intervals the working stress (f) is given by $f = \frac{2a^2}{9t^2}p$, in which a is the pitch in inches of the supporting elements and the other letters have the same significance as already given. The deflection of the plate (v) in inches is given by $v = \frac{p a^4}{36 E t^3}$ where E is the modulus of elasticity, fair values of which are

17,000,000 for cast iron.
28,000,000 for wrought iron.
30,000,000 for steel.

In one form or another the above formulæ serve for most

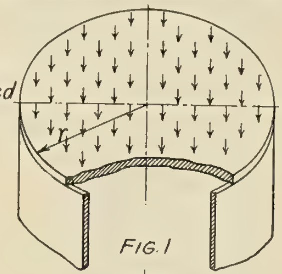


FIG. 1

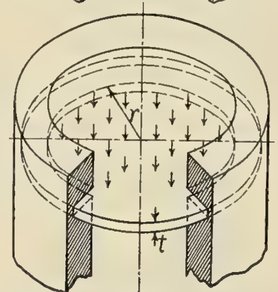


FIG. 2

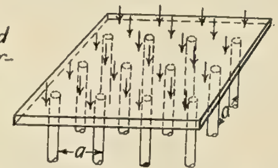


FIG. 3

of the engineering calculations involving the design of flat surfaces intended to withstand pressure. There is no simple calculation for the shell of an oval vessel.

The width at the outer rim of the impeller blades for the pump given would probably be about 4 inches and for the inner rim 8 inches. The pump has a suction diameter which is considerably larger than is common, but there may be some reason for this which is not stated.

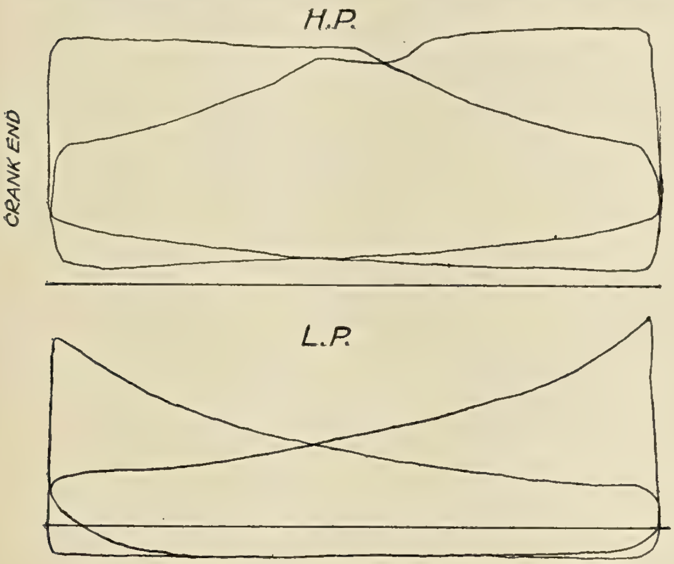
Q.—Will you please explain how the hull of an electric lighted steel ship becomes seriously pitted below the waterline? Also is there any way to determine if this action is going on while the ship is in service? Also what step should be taken to prevent this trouble? SUBSCRIBER.

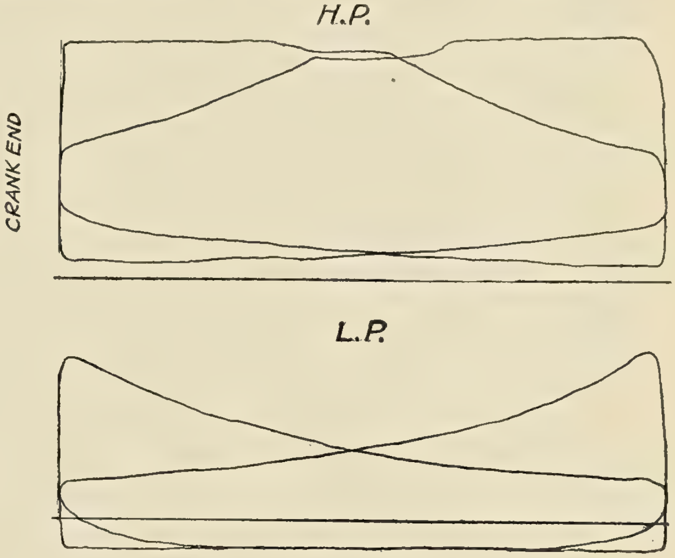
A.—The responsibility for severe local corrosion or pitting of a vessel's shell below the waterline has frequently been attributed to electrical installations of one sort or another. When the single wire system of lighting is used the hull serves as the return conductor and it is possible that in the large electrical installations the return current along the hull structure may be of sufficient intensity to cause slight corrosion at the butts in the plates.

* Assistant Professor of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Boston, Mass.

But the area of the shell is so large and the return current so feeble that under any case generally met with it is quite negligible. With the two-wire system which is now principally used the hull carries no current.

The consensus of opinion of recent years has been that the responsibility for deterioration of this sort comes from some source other than the electric light plant, frequently from local galvanic action as between the steel hull and bronze propeller, pump, or other attachment, and sometimes from acid in polluted water, as may be found when moored near a sewer discharge or the discharge of water from some industrial plants, as gas works. Either of these latter causes will produce rapid and destructive pitting or corrosion. Galvanic action can be rendered harmless by the use of zinc plates attached to the steel hull near the element which forms the other pole. The other can be retarded by frequent painting and cured by removal to clear water. An easy test for acidity is by litmus paper, but if corrosion is pronounced a chemical analysis is better. Occasionally if the insulation is defective there may be an electric leakage sufficient to cause local corrosion, but this is easily stopped by repairing the insulation, which should not have been allowed to reach such a state.





Q.—Please give a complete analysis of the indicator cards shown herewith, which were taken from the engines of the stern-wheel towboat *Advance* of the Kansas City-Missouri River Navigation Company. The high-pressure cylinders are 12 inches diameter and the low-pressure cylinders 24 inches diameter, the engine being arranged tandem. The stroke is 6 feet and the revolutions per minute, when the cards were taken, 26. The scale of spring for the high-pressure cards was 120 and for the low-pressure 40. The steam pressure when the starboard high-pressure cards were taken was 235 pounds gage, for the port high pressure 230 pounds, and for the low-pressure cards 240 pounds. The vacuum when the starboard high-pressure cards were taken was 20 inches, for the port high-pressure cards 18 inches and for the low-pressure cards 19 inches. According to my calculations the horsepower works out as follows:

Starboard	*H. P.*	91, 90	181
	L. P.	68, 74	142
			323
Port	*H. P.*	86.5, 88.5	175
	L. P.	63.5, 62	125.5
			300.5

Total indicated horsepower = 623.5.

What causes the peculiar hump in the admission lines of the high-pressure cards? M. P.

A.—Further data are much to be desired as to type of valve (poppet or slide), valve gear, character and size of receiver and designed cutoff for both cylinders. Lacking these an accurate and detailed analysis of these cards is, of course, impossible, but some points may be noted.

The peculiar irregularity in the admission and expansion lines near cutoff for the high-pressure cards is undoubtedly due to faulty valve action, which permits steam to leak through into the receiver before cutoff occurs. This may be caused (if the valve is a plain slide valve) by the valve momentarily lifting from its seat, or if the valve is of the piston type by an improperly machined valve chest, and therefore a non-cylindrical interior.

The continued reduction in the pressure of the exhaust lines of both ends of both engines indicate serious wire drawing, probably in the exhaust ports to the receiver, or possibly in the admission ports to the low-pressure cylinder, although this is improbable on account of the increased area available due to the increased size of the low-pressure cylinder. With a properly operating valve and sufficient port openings the engines should indicate considerably higher in both cylinders, and probably the gain would be more noticeable in the low-pressure cylinder. The low-pressure cards were not taken simultaneously with the high-pressure, nor even approximately so, as the boiler pressure and vacuum for both engines are radically increased from those existing when the high-pressure cards were taken. This, of course, vitiates their value for the determination of total indicated horsepower, and moreover precludes an accurate analysis of engine action; for example, the exhaust pressure at mid-stroke for the high-pressure cylinder, read from the card, is approximately 20 pounds gage, and the pressure from the corresponding position of the low-pressure card is 4 pounds higher. Taking account of piston rods, the horsepower developed in the various cylinders is as follows:

Starboard—

High Pressure			*Low Pressure*		
Head end........	80.8	152.2	Head end.......	71.0	135.1
Crank end.......	71.4		Crank end.......	64.1	

Total, 287.3

Port—

High Pressure			*Low Pressure*		
Head end.......	78.5	149.6	Head end.......	60.1	120.4
Crank end......	71.1		Crank end......	60.3	

Total, 270.0.

Total both engines, 557.3

In general, however, there seems to be no serious defect shown in the low-pressure cards, and while the low-pressure cylinder is doing less than half the work, in the case of the tandem compound engine this is unimportant, as both pistons are on the same piston rod.

Letters from Marine Engineers

Discussion of the Design and Handling of Marine Engines, Boilers and Auxiliaries—Breakdowns at Sea and Repairs

This department is open to all readers of the magazine for the discussion of affairs in the engine room. All letters published are paid for at regular rates. Your ideas or experiences will be mutually helpful and interesting to other engineers. Write your letter now.

Cracked Cylinder Flanges

The bottom after flanges on the steam cylinder of a tug cracked where they join the engine frame. As it was necessary to use the tug before a new cylinder could be cast, something had to be substituted for the flanges in order to hold down the cylinder.

The engineer obtained two long bolts and a strap of iron, something like an "old man." Two holes were drilled in the iron strap to receive the bolts. The strap was then placed across the top of the steam chest, which faced aft, and the bolts inserted to connect it to the cylinder frame, the bolts passing through the same holes in the top of the frame that were used for the flange bolts.

This arrangement has served its purpose for about three months, giving very little trouble. A new cylinder has been cast, however, and is ready to install on short notice.

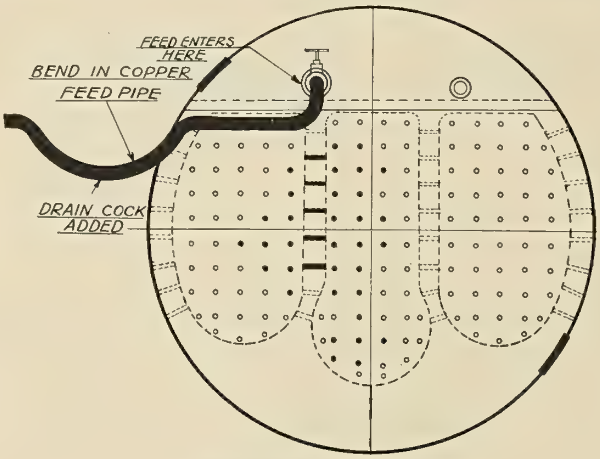
G. T. C.

An Interesting Case of Boiler Corrosion

Some time ago, while serving as assistant engineer on a large cargo boat, the writer ran across a rather interesting and instructive case of boiler corrosion. Boilers are a great problem to engineers and the wherefore of corrosion has caused us many sleepless nights. Some problems are fairly easy to solve, but, then again, a great many go unsolved; again, we sometimes find the cure without getting at the bottom of the trouble, but the only real satisfaction is experienced when we find the trouble and remedy it. The writer believes that a freer exchange of experiences between engineers would be very helpful to us all.

A brief description of the vessel's machinery will help in explaining the difficulty we had in this particular case. We had a triple-expansion engine of about 1,800 indicated horsepower, which ran at 65 revolutions per minute. The air and circulating pumps, both of the bucket type, were run of the intermediate crosshead by the regular link arrangement. On either side of these pumps were arranged in pairs a feed and a bilge pump, both of the plunger type. The feed pumps drew from the hot well and discharged first through a closed type feed heater, where the feed water was heated to a temperature of about 180 deg. F. The feed was then passed through a cartridge type filter and then into the boilers. The boilers were of the ordinary Scotch type, three in number, coal burning, natural draft with a working pressure of 180 pounds per square inch. The pumps and heater were on the port side of the engine and the boiler which gave us trouble was the starboard boiler. The check valves were in the engine room, for the boilers projected through the bulkhead between the engine room and boiler room. The arrangement brought the check valves very high up on the boiler and very close to the combustion chamber side and back stays. No internal feed pipe was fitted.

The first signs of corrosion we found were on the stays from the combustion chamber back to the boiler back head on the center chamber. The stays from the center chamber to the port chamber were also affected. All of these stays were nearly directly under the check valve. The stays were badly wasted away and some were down to less than half the original sectional area. At first it was puzzling that this corrosion should be so marked locally, but when the location of the check valve is considered, along with the fact that the feed pumps were of the plunger type, and that the feed was heated in a closed heater on the pressure side, and thus only to 180 degrees, it is easily understood. Plunger pumps of this type directly coupled to the main engine are as conducive to mixing air and water as they are to pumping, and the closed heater combined with the low final feed tempera-



Arrangement of Feed Pipe

ture did not remove a great deal of the air and, when finally this comparatively cold water was pumped into the boilers and onto the hot combustion chamber plates, conditions for local corrosion were ideal.

However, this did not explain why the corrosion was so much more apparent in the starboard boiler. Of course, its location relative to the pumps and heater would account for a slight amount of extra corrosion, but the difference was too great to be explained in this way. The chief engineer asked for the installation of a pump for an independent feed pump, believing that it would do away with pretty nearly all of this corrosion. The owners, however, were not convinced that this was necessary, so the pump was not installed. All the corroded stays were replaced by new ones before the boilers were set off for another voyage.

Upon opening the boilers again after reaching the end of a long trip we still had this excessive wasting away in the starboard boiler, and we were up against it to find the cure.

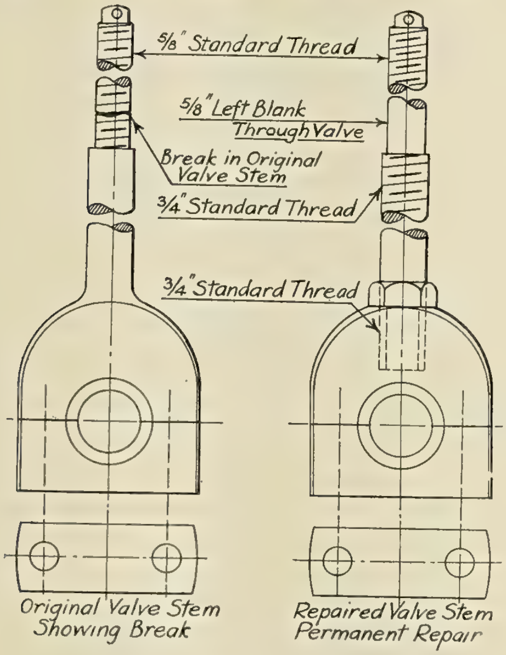
Finally, after eliminating all other possible causes, we hit upon that of galvanic action. At first we could not find anything that would cause this action because the boiler was well supplied with zinc plates. The real trouble we hit upon more by accident than intent. The feed pipe just before entering the starboard check valve had a downward bend, as shown on the sketch. This was, of course,

to take up any expansion in the copper pipe, but it also formed a water pocket. When the pumps were stopped a certain amount of water collected in this pocket and could not be drained off. The water was warm and was permitted to stay there for a week or more at a time while we were in port loading or discharging part of a cargo. The pipe being copper, caused a small chemical action between the pipe and the water, which caused the latter to become very acid. When the pumps were again started all this acid was pumped into the starboard boiler and onto these combustion chamber back and side stays and caused this excessive and rapid corrosion. This theory seemed perfectly logical, so it was decided to fit a small drain cock at the lowest part of this bend, as shown on the sketch. The cock was opened when the pumps were stopped and all the deposited water was drained out. After making this simple and inexpensive repair the boiler showed no more signs of any further local corrosion.

F. Kilian.

Quick Emergency Repairs

The element of time is often of most serious consideration in making emergency repairs and more particularly so in express steamers carrying mail and passengers where detention amounting to fifteen or twenty minutes may cause missing a through train connection. When the emergency arises the problem to be settled at once is what



Repairs to Broken Valve Stem

can be done to make port with the least possible loss of time; of course, always considering "safety first."

One morning at two o'clock the engineer on watch reported to me that the circulator had stopped, and when I got below he had opened the valve chest and we found the valve stem broken off just under the bottom lock nut. We had no spare stem aboard and there was no arrangement provided for running jet condensing; also there was no connection from the fire pump to the condenser. Briefly, the main engine was out of commission until we could "fix" the circulator.

The stem was threaded all the way from the top down through the valve to about 3/8 inch below the bottom lock nut. We squared the broken ends off roughly with a file and screwed the thick nut down to the limit of the thread on the lower, broken end. This took about half the nut. We then screwed the upper part of the stem down into the nut, thus using the nut as a sleeve coupling. The lock nut was then put on and enough washers to bring the valve up to its correct position.

Putting the nuts on the stem above the valve and the cover on the steam chest required a few more minutes, and we were under way after a delay of just twenty-five minutes. By driving we got in about five hours later, practically "on time."

Of course this repair could not have lasted very long, but it got us in, and that was all we required of it, as we had ample time to make permanent repairs before sailing again that night.

We were lucky to have enough of a threaded end below the break to catch the nut on without having to take the stem out and thread it, but the point is that the engineer must instantly see any possible advantage and use it with the least possible loss of time.

On another occasion the cap screw holding the lever on the end of the rocker-arm of the twin-beam Blake air pump broke off flush with the end of the shaft. The lever referred to actuates the valve gear and is bolted to the end of the shaft, the large boss of the lever forming practically an extension of the shaft. The boss of the lever is held central by a light recess turned in the end of the shaft to receive a corresponding projection on the boss of the lever. Two dowel pins hold the lever in its correct radial position, hence the bolt is only required to hold the lever securely against the end of the shaft.

We could not start the bolt out with a chisel, and we could not get a drill at it in place, because the 6-inch discharge pipe came up directly in front of it with only about three inches space between it and the end of the shaft. We cut out a block of wood that, together with a piece of plate for the bolt-head to wear against, just fitted tightly in the space between the bolt-head and the discharge pipe and drove it in, holding the lever up against the end of the shaft.

We were stopped twenty minutes, and while making this repair I did not think it would last half an hour, but it was the only thing we could do that would not require two or three hours' detention. As a matter of fact, it lasted until we got in, which we did practically on time, about five hours after the accident.

Referring again to the broken circulator valve stem, a glance at the accompanying sketches will show how the permanent repair was made. The new design gives the necessary additional strength where needed, with the further advantage of quick and cheap renewals of the stem when badly worn or broken. It would be to the advantage of all concerned if the designing engineers would pay more attention to these insignificant (?) details.

This stem is fitted for a slide valve in a pump with an 8-inch cylinder providing condensation for a main engine and auxiliaries of approximately 2,500 indicated horsepower, and the veessel was built in one of our foremost shipyards less than five years ago.

S.

A Boiler Failure

A boiler, about fifteen years old, on a river tug developed several bad leaks in the back sheet. After laying up the tug all night, the engineer found no water in the glass or gage cocks. This had happened on previous occasions, however, due to the leaks in the back flue sheet.

The steam pressure was low and the engineer turned on the steam jet to blow the fire, but neglected to bring the water level up. When the fire became hot, the tubes

above the three lower rows drew away from the sheets, front and back, showing that the level of the water must have been down to the top of the third row of tubes from the bottom.

This was clearly a case of neglect on the part of the engineer. In the first place, when there is no water in the gage glass and, especially, in the gage cocks, it should be attended to immediately. In the second place, the leaks in the tube sheet should never have been neglected for so long a time. No doubt the failure would have occurred in as short a time if only the first condition obtained that of a low-water level. G. T. C.

Size of Inboard Bearings, Proper Design of Crossheads and Faults of Lubricating Systems

Being Scotch, I have the right by tradition to believe in the mysterious and to be superstitious.

When I first went to sea I listened to the stories of feed pumps that pumped water that never reached the boiler or went anywhere; of boilers that exploded with half their working steam pressure or burnt out when all hands, from the first water tender down, swore that they all knew that at the time of the accident there was a full water gage; of the stop valves that, when wide open, passed no steam, and so on, and believed in them.

My faith in the mysterious was upset and shaken when, being sent aboard another steamer of the line to take the place of a sick "third," I found the engine room in a mess, as a low-pressure piston had given away just as they were warming up and turning over. Happening to push aside a jumper lying on a shelf near a port hole, I saw a very-much-distorted spanner and a chunk of cast iron, on which was plainly visible the imprint of the head of the spanner, and if the captain, who was later looking over the side, had had sharp enough eyes he could have seen the "mystery" disappearing in the water.

Yet, Mr. Editor, in all seriousness, here is a mystery. Why is it that no amount of argument or suggestion from those of us who stand on the gratings can induce designers to do certain things which our experience shows would be advantageous? For instance, we all know that the inboard bearing of the main engine always wears low. From my experience, this is the inevitable condition; yet designers persist in making this bearing too small. They argue that there is no power transmitted through this bearing save that necessary to run the valve gear, and that if they should attempt to make it long there would be too much offset to the rods, "and, anyway, it isn't necessary."

I have gone to the extent of taking a designer down to a speed lathe and showing him how a bit of wire held in the chuck will flop around when run at speed, and called attention to the fact that this was similar to a crankshaft, and was for my pains called "a crank." I saw once in an American compound just the right design for an inboard bearing. The engine was a small one, and the valve gear drove straight up, and a comparatively short bearing was provided between the crank cheek and the eccentric, but outside this, in a solid bracket cast on the bed, was a very long bearing; the eccentric, therefore, worked in a pocket. The engineer in charge told me that he had been running the boat three seasons, and that the crankshaft was in perfect line.

Now, this design was simple enough, and when I showed it to one designer the only argument he had against it was that "everybody would be tumbling over it when they passed around the engine."

When I go into an engine room for the first time I cast my eyes at once on the cross-heads, and I believe this is what every engineer does, because a cross-head gives more trouble than any other part of an engine; that is, as far as my experience goes. To my mind, there is only one design of cross-head which is proper, and that is not common in commercial engines. It is the one where the pin of the connecting rod is shrunk in and the cross-head has a single brass. Usually the forked end of the connecting rod is furnished with two brasses, necessitating two overhung pins (which are never large enough in diameter), and making the exact adjustment and even pressure on each of the brasses impossible, so that there is an uneven wear on them. The designers always shudder with horror when you suggest larger pins—"they weigh more." Sometimes they will concede an extra half inch in length, which I contend is no where near so good as an increase in diameter; yet the idea of setting the cross-head slide a little further back from the center, in order to provide clearance on account of the increased diameter of the pins, is another thing which disturbs the designer's equilibrium.

With the pin shrunk into the connecting-rod end you have a beam supported at both ends, the advantage of which we all admit, and a single brass to adjust. This style is no novelty; yet I have never but once seen it in a commercial engine of large size.

When I first got into the engine room it was under a chief who had the sign habit. He had little placards stuck up on the bulkhead in the shape of proverbs. One was: "A drop of oil where wanted and when wanted is worth a barrel in the crank-pit." Oil, Mr. Editor, is one of the most disobliging things in the engine room; it is lazy and always wants to get away from its work, and you have to make it go where it should. We know that it will never work into a bearing; it will always work out—that we are sure of; yet the filters will usually provide means in the shape of grooves which conduct the oil off the bearing as soon as possible, and so place them that when the thrust for lift on the bearing will cut them off just at the moment when the oil is most needed. A forced system of lubrication is, of course, ideal, provided you have means of knowing that it is constantly working, without waiting for something to run hot. The ordinary gravity feed oiling system is infinitely improved by having the oilways lead the oil to the sides of the bearing, instead of to the top, as usual.

In a crankshaft I insist that there should be three oil holes drilled each side of the center, but instead of the holes leading directly down to the shaft, they should lead to the side of the bearing, coming out at a tangent. This introduces the oil on to the bearing where there is the least pressure, allowing room for the oil to smear itself over the surface. This makes a little more work in the machine shop, but results in far less anxiety for the engine-room force.

Can you get the average designer to show oilways made as described? As they say in the States: "Not on your life!" When it comes to forcing oil through pipes it seems to be forgotten by those who erect piping that oil is not free from dirt and that ample means should be provided for thoroughly cleaning out oil tubes every now and then, and doing it quickly. It is quite common to have a large tube running fore and aft on an engine, with branches from it leading over to the main bearing; for instance, these branches are usually curved and look real pretty, but I want, instead of this curved tube, two straight

pipes—one horizontal and one vertical, with a tee connection; one of the three holes being closed with a plug having on it a knurled headed plug, so that it can be quickly taken out and returned without the use of a wrench. Of course, these tubes, fittings and plugs should be of composition.

Any system of oil tubing should be connected up to a steam supply, so that it can be blown through. Now, with this system of tee and plug, the steam can blow out all the tubing except the vertical, short run down from the tee to the bearing, without blowing the dirt into the same.

The experience of human beings will, of course, vary, and it may have been only my personal experience that leads me to make the above remarks; yet, in talking with my brother engineers, I find them invariably agreeing with me on the points to which I have drawn attention.

Anti-Mystery.

Bearings for Shafts, Etc.

The duty of a crank bearing is to take up the pull or push which is exerted on the shaft. Before the shaft turns, the friction moment must be overcome by a turning moment. This friction moment is a certain loss, and therefore it must be made as small as possible. If P is the load on the bearing and f the coefficient of friction, then the frictional resistance $= P \times f$. But this is only true for dry surfaces, or for surfaces which are lubricated with graphite.

It is commonly asserted that the frictional resistance is not dependent upon the velocity of rubbing, but this is also only true for dry surfaces. For bearings with oil we have the equation:

$R = f \times p^n \times v^m$ where,

R = force of friction acting on every square inch of bearing surface.

f = a constant.

p = the normal pressure in pounds per square inch.

v = velocity of sliding surface.

^{n} = an exponent depending on the value of lubrication and varying between 1 for dry surfaces and .4 for ring-lubricated surfaces.

^{m} = an exponent also depending on the lubrication and varying between 1 for dry surfaces and .5 for surfaces moving in an oil bath.

The material of the rubbing surfaces, if these are well lubricated, has only a secondary influence on the friction, but it has an influence on the quantity of oil which must be fed, and also such materials must be selected as will run if the lubrication is stopped for a short time. In most cases the steel shafts or pins of marine engines run in white metal lined surfaces, but only where the bearings are not exposed to shocks; in crosshead bearings, and the bearings for the pump gear, the white metal may better be omitted.

The only reason why white metal is better than bronze is that, it being plastic, it accommodates itself exactly to the journal, so that the shaft does not bear on some one point, as it is likely to do with a bronze bearing, which point must be scraped away in order to get a good bearing surface. Cast iron on cast iron runs very well, but with such conditions great care must be taken or this material will grip. Serious accidents have occurred with cast iron eccentric straps running on the cast iron sheaves. Cast steel crosshead shoes on cast iron slides run very well and need little oil. The crosshead pins and the pins of the valve and engine pump gear nearly always work in phosphor-bronze bearings; formerly it was tried to have the pins and bearings of hardened steel and truly ground. In many cases little trouble was experienced, but at times a breakdown took place, owing to the gripping of the ground pin and bearing.

On the torpedo boat G this practice was in use in connection with the valve gear, the links also being hardened and ground and provided with hardened bushes. On the first trial trip, when running at about 400 revolutions per minute, the ahead eccentric pin and bush gripped; a heavy knock was heard, after which the engineer closed the stop valve as soon as possible. It seemed that the eccentric, which was of 5 percent nickel steel, had broken close to the forked end. The color of the material was a dull blue. The pin could not be moved after it had gripped, so the shaft turned the eccentric, which was only made possible by the bending of the eccentric rod, and it soon broke. The violent moving of the molecules caused considerable heating of the rod. The rectangular section of the rod at the point of breaking was 1⅜ inches by ⅝ inch and the rod was nickel steel.

The high-pressure piston valve was taken out and the boat steamed with reduced steam pressure to the engine works, where a new rod was made.

Very often the pins are of nickel steel and the bearings of phosphor-bronze. This steel is of a very fine structure and, being harder, the wearing is less than with common Siemens-Martin steel. But the best of all for crosshead

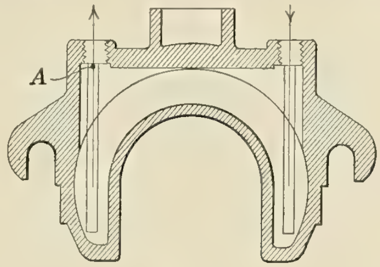


Fig. 1

bearings and valve gear and pump gear is a hardened and ground pin on a hard bronze bearing. The wear with this construction is very small and, in the writer's practice, it has occurred that after six years' running it was not necessary to remove even one of the thin plates or shims inserted between the brasses from the crosshead bearings of a triple-expansion engine running at 150 revolutions per minute.

For thrust bearings it is always the best to have the iron or cast steel segments lined with white metal and provided with ample oil grooves. It must be remembered, however, that it is not good practice to have a single hole from the oil cup divided into two leads, one to the ahead and one to the astern faces, as is often provided. When the rings get a little play, all the oil, when running ahead, runs to the astern side, so that the ahead side is not sufficiently lubricated.

To have the segments hollow, with cold water circulating through them, is excellent practice. It must not be forgotten that a hole must be drilled at A, Fig. 1, to allow the air to escape, or the air will be trapped and the cooling water will not reach all the rings. The water service piping is most commonly connected to the inlet and outlet of the circulating water, which gives a good flow of cold water.

The only trouble with cooling the thrust-bearing segments is that, if they heat up quickly, they still feel cold for a time, so that the engineer is misled.

D. K.

Marine Articles in the Engineering Press

New Harbor Improvements—Naval Topics Brought Up by the European War—Interesting Discussion of High-Speed Bearings

Protection Against Fire On Board Ship.—It is stated that, although great developments have taken place in every detail of the design of merchant steamships, little or no progress has been made towards the effectual protection of the ship against fire, except in the pumps and distribution of pressure water from them. The question is not only one of preventing a possible outbreak, but of quickly and effectually arresting it in the initial stages. A review of the methods used on board ship and also in warehouses, etc., shows that the automatic sprinkler system is used quite extensively. An improvement in this system, in the form of a differential valve with water pressure on one side and air pressure on the other, eliminates the possibility of the water freezing. This is called the dry-pipe system and the water is released when the air pressure in the pipes is relieved by the melting of the solder in the nozzle. Where such systems are impossible, as in cargo holds, a system introducing carbon dioxide is used to advantage. Sulphur dioxide has been used, but one authority found it objectionable, claiming that men could not live in an atmosphere containing any appreciable amount of the gas. The use of steel furniture and the substitution of light steel and plaster for wooden decks, cabins, partitions, etc., is said to be largely a question of expense. There can be no question that a ship so treated would be more immune to fire than an ordinary vessel depending largely on the fire-pumps; but the final answer, it is feared, is one concerned with the relation of safety and its influence on earning power, to the cost involved. Shipowners have shown such readiness to add to the comfort and speed of their vessels that there is no doubt they will meet the demands that are commercially practicable. 1,400 words.—*Engineering,* July 10.

The Port of Calcutta.—The congestion of trade at the premier port of the Indian Empire is bound to have a disturbing influence over a wide area, apart from the consideration that during the past few years it has become only too evident that the inability of the port authority to cope satisfactorily with an ever-increasing volume of commerce was seriously impeding the growth and development of the port and undermining its prosperity. From time to time committees have been appointed to inestigate the conditions and make recommendations for a solution to the complex problem. It remains to be seen whether the proposals now put forward by the present committee will meet with any more favorable fate than any of their predecessors. Sea-going shipping at Calcutta has hitherto been accommodated either at jetties in the River Hooghly or at the Kiddepore Docks. The jetties have been conspicuous for the degree of congestion prevailing along their frontage, and for the inadequacy of their facilities for the discharge of cargoes. At the docks the defects are in regard to insufficiency of accommodation and an unsatisfactory entrance arrangement. The quayage of Dock No. 1, which was formerly adequate for twelve vessels, now only suffices for eleven, and sometimes for ten. The defects of the entrances are even more serious and vital. There are two entrances—one a lock, 60 feet wide and 400 feet long between gates, and the other a simple entrance 80 feet wide with a single pair of gates. Both are inadequate for modern shipping. The proposals in regard to dock extension put forward in 1906 are practically identical with those which now receive the approval of the Commission. The scheme comprises a new dock system on land which has already been acquired in the vicinity of Garden Reach, consisting of a turning basin or main dock, with a minimum dimension of 1,000 feet and two arms or branch docks, running approximately north and south, with widths of 600 feet and 700 feet respectively. The depth of the dock is fixed at 35 feet. The entrance is designed to allow continuous docking and undocking of vessels throughout the twenty-four hours. It is proposed that the lock shall have a length of 1,200 feet, divisible into two sections of 700 and 500 feet, by which it will be possible to pass either one or two vessels through the lock at a single operation, saving time and water. The width proposed is 90 feet but 100 feet is preferable. The Commission advocates the inception of the new dock, comprising five internal berths and its entrance, together with five riverside berths at Garden Reach, a distributing depot at Beliaghata for the delivery of imports from the docks, an enlarged junction yard for the reception and despatch of railway traffic, and the realinement of the Budge-Budge branch of the Eastern Bengal State Railway. The recommendations involve an immediate expenditure of about $14,400,000. 1 illustration. 2,000 words.—*Engineering,* July 17.

The East Harbor of Berlin.—To improve the waterborne traffic of Berlin, the east harbor was established upon a narrow waterfront of the river Spree of about twenty-five acres. It shows a central stowage space in buildings or ground and railroad tracks on each side, covered by elevated crane tracks on the water side. The buildings, some up to eight stories high, are prepared for reception of grain and package freight, while bulk freight may be stored outside. The necessary elevator cranes, chutes, conveyors, etc., are fitted, all driven by electric motors. The buildings are stated to be substantial fireproof constructions of pleasing architectural design. Special care is given to storage of gasoline (petrol), with all the latest safety appliances. The powerplant contains two 350 horsepower and one 175 horsepower Diesel engines, direct connected to 500-volt, direct-current dynamos, and supplemented by a storage battery of over 1000 ampere hours. The total cost was approximately $4,300,000 (£880,000), with a capacity for about 37,000 tons grain and freight. 30 illustrations. 9,300 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* July 4 and 11.

Tension Measurement on Board Ship.—The modern search for greater clearness and fuller knowledge is extended in this article to the critical consideration of strength calculations of ships and their possible supplement by experimental determination of material extensions of the incorporated parts of the structure. It is pointed out that aside from the longitudinal stresses of the hull in toto, so many local stresses in their statical as well as their dynamical aspect enter the problem of rational judgment, that the author thinks experimental compilation of extensions the only reliable source of knowledge on this complicated subject. There is described the Marten's mirror apparatus, used by the author in his experiments, consisting of only a short measuring bar, sometimes not more than 8 inches long, a mirror, camera with

lens and film and a source of electric light. The conclusions the author arrives at from measurements on winter voyages of the North German Lloyd steamers *George Washington* and *Bremen* are that the observed longitudinal stresses are less than usually obtained by calculations, and that liability to fracture is more pronounced from sudden impacts by waves and from fatigue of the metals. 23 illustrations. 6,600 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* July 18.

The Application of Electricity on Merchant Vessels.—The history and development of electric installations on board merchant vessels are exemplified in this article by successively built ships of the North German Lloyd Company. It shows the gradually increasing size of the lighting plant with different dynamo combinations, one or two wire lines, special emergency sets, direct current versus alternating current, influence on compasses and dynamo construction. Further are pointed out the widely extended application to power purposes in winches, ventilators, pumps and to heating, also the preference of manually controlled shunt dynamos over compound dynamos and installations of storage batteries to take peak or minimum loads. The advantage of economical reciprocating steam engines, as described, over turbo sets is mentioned particularly for cargo vessels with reciprocating engines. Some new electric engine and navigation telegraphs are described, which by alternating-differential currents produce a very definite indication of signals. Electric winches of the small speed and portable type are finally considered. 30 illustrations. 7,000 words.—*Zeitschrift des Vereines Deutscher Ingenieure,* June 13.

The Submarine in Naval Warfare.—Admitting that the submarine has proved a serious menace and warrants the most vigilant precautions against its attacks, it is pointed out that as a weapon of destruction the submarine is not yet perfect. So far in the present war, submarines have failed to prevent an effectual blockade of a belligerent coast. Of four known attacks delivered by German submarines, three have been repulsed with loss to the enemy, and it seems evident that improvement and development in the vital features of submarine design are necessary before such vessels will attain the offensive value credited to them by theorists. As yet experience is lacking as to the effect of a torpedo attack on a capital warship. The question of defense against submarines should nevertheless be carefully considered. The present methods used by the British fleet are fleet tactics, gun fire and mine and nets. The first two have proved successful so far in the present blockade operations, but the experience of the past three months leads to the conclusion that a new fleet unit must be evolved, capable of repulsing under water attack. It is expected that the present naval warfare will furnish the necessary data for developing a suitable design for such a craft. 1 illustration. 1,300 words.—*The Shipbuilder,* November.

Cargo and Passenger Steamers for British Guiana.—Six twin screw passenger and cargo steamers, designed to meet the general requirements of service in tropical climates, have recently been built and engined by Messrs. Philip & Son, Ltd., Sandquay Engineering Works, Dartmouth, to the order of the Crown Agents for the Colonies. The vessels are named the *Arawana, Arapaima, Baira, Haimara, Lukanani* and *Pirai,* and were launched in the order named, the latter having been completed in September. The boats are 100 feet long between perpendiculars, 23 feet molded beam, 9 feet molded depth and 7 feet normal load draft. They are single-decked vessels with the space below the main deck subdivided by four watertight bulkheads, the machinery being in the central compartment with a cargo hold both forward and abaft of the machinery. Accommodations for 75 first class day passengers are provided on the main deck and 15 first class passengers on the promenade deck. The third class accommodation is on the after part of the main deck, while the crew is berthed in the forecastle. The propelling machinery consists of two sets of compound surface condensing engines, having cylinders 10 and 20 inches diameter and 14 inches stroke, designed to run at 170 revolutions per minute, giving the boats a mean speed of 10 knots. Steam is supplied by a return tube boiler 11 feet diameter by 10 feet 6 inches long, working under a pressure of 140 pounds per square inch. 4 illustrations. 1,000 words—*The Shipbuilder,* November.

Parsons Marine Geared Turbines.—One of the common objections raised against the turbine system of propulsion is that it does not conduce to easy handling or maneuvering of a vessel. As evidence that this objection is not well founded, the case is cited of H. M. S. *Badger,* the first British warship to be fitted with geared turbines, which recently rammed and sank a German submarine boat. Further proof is offered in the operation of war vessels at the "Fight of the Bight." The strongest evidence is found, however, in the case of the new Cunard liner *Transylvania,* a ship 567 feet long, 66 feet 6 inches beam and 45 feet depth, which is the first transatlantic liner to be fitted with geared turbines. The machinery is arranged to drive twin screws, a high-pressure and low-pressure Parsons reaction turbine being fitted to each shaft through the medium of spur gears. The gear wheels are 10 feet diameter and 5 feet broad. At full power the turbines run at 1,630 revolutions, while the propellers turn at the rate of 130 revolutions per minute. The full power is 9,500 shaft horsepower and the speed 16½ knots. The steam consumption of the turbines is only 11½ pounds per hour per shaft horsepower. Further attention is attracted to geared turbines in a paper recently read before the Institution of Engineers and Shipbuilders in Scotland, which gives particulars of the machinery for a number of vessels typical of various classes and for the same ships, designs, weights, etc., of geared turbine installations. While these data are more or less empirical, they nevertheless show the distinct advantage gained from the reduced steam consumption in geared turbine installations over the ordinary reciprocating or turbine drives. 1 illustration. 1,000 words.—*Engineering,* October 30.

New German and Austrian Warships.—The latest battleships for the German fleet are of the *König* class, of which three are completed and a fourth is rapidly nearing completion. These battleships are 580 feet long, 97 feet beam, 27½ feet mean draft, 26,575 tons displacement, armed with ten 12-inch, fourteen 6-inch and ten 3.4-inch guns and five submerged torpedo tubes. They are propelled by three sets of turbines, designed to develop 28,000 horsepower, supplied with steam by fifteen Schulz-Thornycroft boilers. The designed speed is 20½ knots. The main armor belt is 13.7 inches thick amidships, tapering to 6 inches at the bow and stern. This is surmounted by 8-inch armor and the usual 3-inch protection deck is provided. The main battery is mounted in five two-gun turrets all on the centerline of the ship. When compared with their contemporaries, these ships are deficient in gun power, although they are well protected. Two new battle cruisers, the *Derfflinger* and *Lutzow* have just been added to the German fleet and are the first German cruisers to carry the 12-inch gun. The vessels are 689 feet long, 95 feet beam, with a draft of 27¼ feet and a displacement of 26,600 tons. The main armor belt is 12 inches thick, tapering to 4 inches at the ends. The armament consists

of eight 12-inch, twelve 6-inch, twelve 3.4-inch guns and four torpedo tubes. The designed horsepower is 63,000 and the speed 26.5 knots. The latest German light cruisers are the *Graudenz* and *Regensberg,* of 4,900 tons displacement, 456 feet long by 45 feet beam, with a mean draft of 17 feet. The armament comprises twelve 4.1-inch guns and two 20-inch torpedo tubes, the heaviest armor being 4 inches thick. The turbines develop 25,500 horsepower, giving a designed speed of 28 knots. As compared with contemporary vessels in the British Navy it is pointed out that the German cruisers are inferior in gun power, although they are faster and have larger bunker capacity. The latest German destroyers are of about 650 tons, equipped with five torpedo tubes, two 24-pounders and two machine guns, with the turbines developing 16,000 horsepower, a speed of 32.5 knots is usually exceeded on trial. In the Austrian Navy the battleship *Prinz Eugen* has been completed and the *Svent Istfan* is near completion. These are the third and fourth ships of the well-known *Viribus Unitis* class displacing 20,000 tons, carrying twelve 12-inch and twelve 6-inch guns. The speed is 21 knots. Three light cruisers of the *Spaun* type, displacing 3,500 tons and driven by turbines of 25,000 horsepower at a nominal speed of 27 knots, have also been added to the Austrian Navy. They are equivalent to the British *Active* class, having an advantage of two knots in speed, although they are inferior in gun power. The new Austrian destroyers, each displacing 800 tons and having a speed of 32 knots, carry two 3.9-inch guns and four 12-pounders, as well as two torpedo tubes. 8 illustrations. 1,850 words.—*The Shipbuilder,* November.

Aeronautics.—By Algernon E. Berriman, M. I. A. E., A. F. Aé. S. A brief description of airships and aeroplanes leading up to the problem of equilibrium in the air. 5 illustrations. 4,100 words.—*Transactions of the North-East Coast Institution of Engineers and Shipbuilders,* September.

Wireless Telegraphy.—By H. Fothergill. A very complete paper explaining the theoretical and practical development of wireless telegraphy, including detail descriptions of all common wireless systems. 27 illustrations. 10,000 words.—*Transactions of the North-East Coast Institution of Engineers and Shipbuilders,* September.

High Speed Bearings.—By Gerald Stoney, F. R. S. In discussing the three principal types of friction in all bearings—that is, constant friction where both surfaces are dry, greasy friction where there is a more or less complete film of oil between the surfaces, and complete lubrication where there is a complete oil film between the surfaces and no metallic contact—the author refers to the experiments of many investigators. Tower's experiments showed that friction is nearly independent of the load and much smaller than is generally supposed. He also directed attention to the fact that the weight on the bearing was really borne by the oil film, which is thicker at the incoming than at the outgoing edge, and that the oil must have a certain viscosity proportional to the pressure. Tower experimented with a bearing 4 inches diameter and 6 inches long, the brass embracing a full half circle and being accurately scraped to an easy fit to the shaft. The brass was on top and the shaft dipped into an oil bath so as to insure complete lubrication. He showed that the oil film was under very considerable pressure and demonstrated the distribution of pressure. The general result was that with olive oil at 90 degrees Fahrenheit the friction was nearly independent of the pressure and increased approximately as the velocity, $V^{0.6}$. Goodman experimented with a bearing 2 inches diameter and 4 inches long running at 233 revolutions per minute, equivalent to a surface speed of 2.04 feet per second, with an oil bath maintained at a temperature of 40 degrees Centigrade, and found little difference with loads varying from 50 to 550 pounds. He also found that the total friction was proportional to the arc of contact, which he varied from the full arc of 2 inches down to ½ inch, the shear resistance being constant at .36 pound per square inch taken on the chord of the arc of contact. This reduction of the arc of contact has been used in railway journals to reduce the friction. The principal published experiments on high speed bearings are those of O. Lasche. From his experiments it is evident that the material of the journals and bearings makes little difference, as would naturally be expected when the machinery is entirely supported by an oil film. At the higher temperatures all the oils would seem to yield about the same results, while the friction is roughly inversely proportional to the temperature reckoned from freezing point. The general result of the experiments is that approximately up to $v = 2.5$ meters per second the friction varies as the square root of $V^{1/5}$; from 2.4 to 4 meters per second as about $V^{1/5}$; and above 10 meters per second is nearly constant. These tests show that so far as friction is concerned it is not well to use a large shaft and a long bearing, but experience shows that for high speeds and heavy loads long bearings are necessary, and they also have to be large to avoid vibration and critical speeds, and also the risk of fracture due to vibration. In turbine work a rule much used for deciding the size of bearings has been that the product of the speed by the pressure should not exceed a certain figure; but it is doubtful whether this rule is of much value, as it really assumes greasy friction and not perfect lubrication. In land work a product of 5,600, or 75 pounds per square inch at 75 feet per second, has rarely been exceeded. At lower speeds, higher pressures are used satisfactorily. In a discussion before the American Society of Mechanical Engineers, it was stated that speeds of 80 feet per second and 100 pounds per square inch were commonly employed in America, and where there is no risk of heavy vibration there does not seem any reason why higher pressures should not be used. In marine turbines the journal speeds are much lower than on land, and rarely exceed 30 feet per second, and the pressures are usually 80 to 100 pounds per square inch and it is probable that pressures of 150 pounds, or even possibly 200 pounds, per square inch could be used, especially if the oil temperature does not exceed 100 to 110 degrees Fahrenheit, as is usual in marine work. In all high speed bearings artificial means have to be used to carry off the heat, radiation from the bearings not being sufficient. The general plan is to have such a flow of oil from the bearing as to cause the heat generated to be carried away without an undue rise of temperature. Water-jacketing the bearings has been used in some cases, but is not as satisfactory. 13 illustrations. 4,000 words.—*Transactions of the North-East Coast Institution of Engineers and Shipbuilders,* August.

Monthly Shipbuilding Returns.—The Bureau of Navigation, Department of Commerce, reports 100 sailing, steam and unrigged vessels of 21,724 gross tons built in the United States and officially numbered during the month of October. Eight of these vessels were steel steamships, aggregating 13,937 gross tons. The largest vessel completed during the month was the *Great Northern,* of 8,255 gross tons, built by William Cramp & Sons' Ship & Engine Building Company, Philadelphia, for the Spokane & Seattle Railroad Company.

Institution of Naval Architects.—The next annual meeting of the Institution of Naval Architects will be held in London on March 24, 25 and 26.

New Books for the Marine Engineer's Library

Some New Books on Boilers and Revised Editions of Old Ones — A New Edition of Simpson's Naval Constructor

STEAM BOILERS. By E. M. Shealy. Size, 6¼ by 9⅜ inches. Pages, 350. Illustrations, 184. New York and London, 1912: McGraw-Hill Book Company, Inc. Price, $2.50 net.

As this book is intended for the use of firemen and others who are in responsible charge of boiler rooms, it is given over almost wholly to the subject of the operation of boilers rather than to their design. Chapters on the chemistry of combustion and fuels form a basis for the study of the proper burning of fuels. These are followed by descriptions of firing and smokeless combustion of coal. Chapters are also included on the care and inspection of boilers and boiler testing. As a text-book for correspondence students, for which it was primarily written, it is excellent for practical study, and although it does not refer especially to marine practice, nevertheless it should be a valuable asset to those operating any type of boiler.

OIL FUEL FOR STEAM BOILERS.. By Rufus I. Strohm. Size, 5 by 7 inches. Pages, 140. Illustrations, 63. New York and London, 1914: McGraw-Hill Book Company, Inc. Price, $1 net; 4/2 net.

This book is one of the series, called the Power Handbooks, which is frequently referred to as the "Best Library for the Engineer and the Man Who Hopes to be One." The purpose of the volume is to describe the underlying principles in the use of oil as a fuel for steam boiler practice. The construction and operation of various types of burners, together with their arrangement in different boilers and the operation of pumps, heaters, etc., are described clearly and in many cases by excellent drawings. No special reference is made to marine practice, as the subject matter is confined to stationary boilers.

MARINE STEAM. Second Edition. Size, 7½ by 10½ inches. Pages, 220. Numerous illustrations. New York and London, 1914: The Babcock & Wilcox Company.

While this book is issued as a catalogue descriptive of the boilers manufactured by the Babcock & Wilcox Company, the engineering data given, showing the results obtained with watertube boilers in a great many different installations, are of great interest and value from an engineering standpoint. A short historical review of the development of the Babcock & Wilcox boiler is followed by a detailed description of the present types. Throughout, the modern boiler has been compared to the ideal boiler as outlined in the late Admiral Melville's list of essential characteristics. The book is very complete. It contains much accurate data that cannot be obtained elsewhere, and should have a place in every marine engineer's library on account of the extensive use of the Babcock & Wilcox boiler in marine practice.

STEAM BOILERS. Third edition. By C. H. Peabody and E. F. Miller. Size, 6 by 9¼ inches. Pages, 543. Illustrations, 229. Folding plates, 5. New York and London, 1912: John Wiley & Sons and Chapman & Hall, Ltd. Price, $4; 17s. net.

Authoritative books on steam boilers are not very plentiful. What few there are, either deal directly with the thermodynamics of the generation of steam or with the mechanical details of boiler construction. In this book, which was primarily intended for the use of students in technical schools and colleges, theory and practice each have an equal share in the explanation of the construction and operation of steam boilers. The subject is thoroughly covered by giving only clear and concise statements of facts concerning boilers. No preference has been given to any one particular type, each type being described in detail. Following a description of various types of boilers, a chapter is devoted to superheaters and this includes a short discussion of superheated steam. The chapter on combustion has been extended in this edition to cover oil burning and to include the most recent analyses of American coal, together with a detailed description of coal calorimetry as applied to the determination of the heating value of coal purchased on a heat unit basis. This chapter alone would make a very interesting book, as the matter has been presented in the careful and thorough manner which is characteristic of the authors. Corrosion and incrustation are discussed in great detail, and the subjects of mechanical stokers, economizers and steam piping have been treated at considerable length. The new edition also includes new material on chimney draft and a chapter on coal handling and coal-handling machinery. The subjects of riveted joints, boiler testing and staying flat surfaces have also been extended and are very complete. The design of the horizontal return tubular boiler is the only one taken up in detail as the principles in the design of different types of boilers are the same throughout.

THE NAVAL CONSTRUCTOR. Third edition. By George Simpson. Size, 4⅛ by 6⅜ inches. Pages, 819. Illustrations, 366. New York, 1914: D. Van Nostrand Company; London, 1914: Kegan Hall. Trench, Trübner & Company, Lt. Price, $5 net.

In practically every branch of the engineering profession there is available a standard handbook giving in condensed form for ready reference the principal data constantly required by the engineers, draftsmen and manufacturers specializing in that particular branch. Naval architecture is no exception in this respect, and, in this case, the need is admirably filled by Simpson's "Naval Constructor," the third edition of which has just come from the press.

From its first appearance, ten years ago, the "Naval Constructor" has been noteworthy in the manner in which "unified details" are presented. The new edition has been considerably enlarged by the addition of further "unified details" and new matter dealing with ventilation and other subjects, while the old matter has been thoroughly revised and brought up to date.

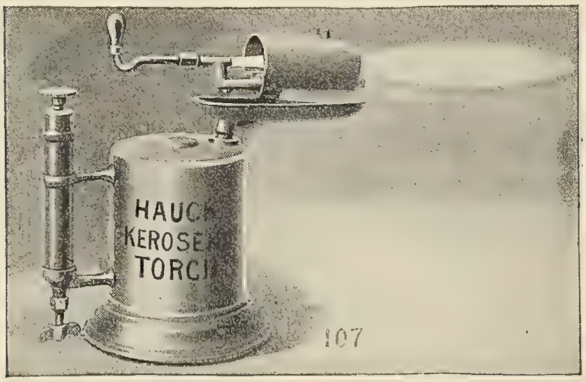
The book is divided into seven sections, dealing respectively with ship calculations, strength of materials, fittings and details, rigging and ropes, equipment, miscellaneous data and mathematical tables. The first section, which covers 277 pages, is in itself a valuable text-book, and treats the subject of ship calculations in a thoroughly practical manner. The chapter on freeboard, including freeboard tables, is of special value, as also are the tables of weights, the notes on specification writing and the chapters on strength of ships and resistance. In this connection, an interesting table gives some useful data covering vessels varying from 65 to 600 feet in length. While much of the information regarding the strength of materials can be found elsewhere, that which refers to the strength of columns, shackles and riveting is specially convenient for naval architects.

The third, fourth and fifth sections of the book, which cover over 400 pages, give a mass of useful data collected from a great variety of sources, and it is presented in a most convenient and useful manner. The thousand and one details given in these pages are constantly needed by designers and others who have to do only with the maintenance and operation of steam vessels. The author's careful compilation of this information will be widely appreciated.

ENGINEERING SPECIALTIES

The Hauck Kerosene (Paraffin) Torch

A kerosene (paraffin) torch of new and novel design, especially made to take the place of the gasoline (petrol) torch, has just been placed on the market by the Hauck Manufacturing Company, of Brooklyn, N. Y. The most important feature is the construction of the bronze burner. The oil passageways are especially large and so arranged that only one plug has to be unscrewed in order to clean the whole burner instantly. By a special oil regulating valve the flame can be adjusted to any size from 8 inches long by 1 inch in diameter to the finest point.



Hauck Kerosene (Paraffin) Torch

As kerosene (paraffin) contains more heating units than gasoline (petrol), the temperature obtained with this torch is much higher than that of the gasoline (petrol) torch, which makes it especially suitable for brazing pipes, wires and small machine parts, burning off paint, shrinking and expanding, as well as for general ship repair work. It is also claimed that strong wind or cold weather will not effect the flame in any way, and it is therefore especially recommended for use on board ships and for outside work.

The torch is also furnished in connection with a light furnace for melting solder and heating soldering coppers.

Vismera

The Inland Steel Company, Chicago, Ill., is manufacturing *Vismera* rust- and corrosion-resisting iron sheets which are particularly adaptable to the construction of ships' hulls or for the roofing of docks, warehouses, etc. In manufacturing *Vismera,* it is claimed the possibility of any foreign substance getting into the material is avoided and that 90 percent new pig iron is used from the ore, together with 10 percent of *Vismera* crop ends. This is refined to a certain point and the resulting pure iron content is said to be from 99.55 to 99.60. An alloy is then made in the ladle containing this pure iron content with .2 of pure copper and .2 of pure manganese, which is claimed to result in a total purity of alloyed metals of practically 99.932 percent.

From experiments, in which an ordinary block of steel and a block of *Vismera* were welded together and suspended in a 20 percent solution of sulphuric acid for thirty hours, it was found that the steel was badly eaten away and the *Vismera* was untouched by corrosive action. Superiority is further claimed by means of various tests side by side with various brands of iron, steel and "metal," such as tests in wet sand, air and water, air and salt brine, gases, fumes, snow and rain.

Vismera sheets are offered black and galvanized, in all standard sizes and gages.

New Watson-Stillman Hydraulic Jack

The Watson-Stillman Company, New York, has just brought out a new type of hydraulic jack that embodies features entirely new in hydraulic jack construction. Primarily the design was intended to cover the demands of an emergency jack for street railway use, but according to the manufacturers it has proved so sure and reliable at all times, so easy to handle and operate, that it will be welcomed by any shop or factory where lifting work is occasionally or constantly performed. By referring to the illustrations the following unusual features will be noted:

1. The claw can be moved vertically and adjusted to the most convenient height, and can with the cylinder be swung in a complete circle without changing the position of the jack or of the pump level.

2. The cylinder is the moving part of the jack instead of the ram, as in the ordinary type of jack, thus allowing the pump mechanism to stay in a fixed vertical position and permits the working parts of the jack to be made simpler and more compact than is usually the case.

3. The piston is packed with leather rings, the valves are of the ball type, and all passages are made amply large, resulting, it is claimed, in a practically fool-proof construction.

4. This jack is operated with a special oil which, it is claimed, as well as acting as a lubricant, prevents rust on working parts, the possibility of freezing, and has no detrimental effect on the packings.

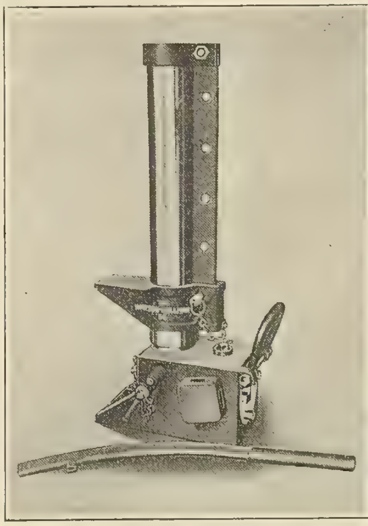


Fig. 1.—Hydraulic Jack

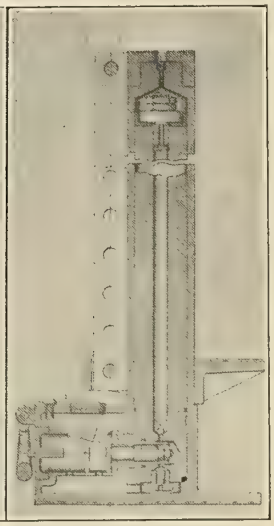


Fig. 2.—Section of Jack

5. The releasing of the pressure is by a key operating a small needle valve.

6. While the operating lever is but 18 inches long, one man weighing 125 pounds can obtain the maximum pressure with but slight effort. The lever is made curved in shape and the socket has a hole in each of its four sides to allow convenience in operation from practically any position.

These jacks are now built in 5- and 10-ton sizes, with a ram stroke of 10 inches, and are guaranteed to stand a 50 percent overload without detrimental effect to any of their parts.

Personal

Samuel Hutton will finish the season as chief engineer of the steamer *Betty* at Waterford, N. Y., on the upper Hudson.

John Falkerer, formerly with the New London Towing Company, has accepted a position as chief engineer of the steamer *Joseph Garrett,* of New Haven, Conn.

Ten Eyck Hotaling, of Stuyvesant, N. Y., chief engineer of the *Sirius,* of the Iron Steamboat Company, New York, will make his home at Edgewater, N. J., during the winter.

Frank Gosselin, chief engineer of the twin screw steamer *Julia Safford,* has taken a position with the McHarg Construction Company, Albany, N. Y., for the winter months.

John W. Waters, formerly New York representative of the Kingsford Foundry & Machine Works, Oswego, N. Y., has been appointed local inspector of boilers at San Juan, Porto Rico.

Joseph Lindsley, formerly employed by the Bridgeport Towing Company, Bridgeport, Conn., has accepted a position as chief engineer of the tugboat *Joseph Penn,* of New Haven, Conn.

H. H. Hodell was elected president of the Van Dorn & Dutton Company, Cleveland, Ohio, at a special meeting of the board of directors, held October 12, to fill the vacancy caused by the death of James H. Van Dorn.

C. L. Morrison, who has for a number of years been marine superintendent of the Lackawanna Steel Company, has accepted the position of chief estimator for the Seattle Construction and Dry Dock Company, Seattle, Wash.

Naval Constructor D. W. Taylor, it is understood, will be appointed chief of the Bureau of Construction and Repair, Navy Department, Washington, D. C., on December 13, when the appointment of Chief Constructor R. M. Watt in that capacity expires.

E. H. Weaver, shipping manager of the Benedict, Manson Marine Company, of New Haven, Conn., which operates a large fleet in the coastwise trade, has been elected an honorary member of the Marine Society of New York. This society was organized in 1746.

Albion Saulsbury, who is eighty-one years old and a pioneer engineer on the Hudson River, suffered a paralytic stroke at Rensselaer, New York, October 25. For a good many years Mr. Saulsbury was chief engineer of the steamer *City of Hudson.*

Samuel Shoemaker, recently with the government fleet on the Ohio River, has accepted the position of assistant engineer on the towing steamer *John Summers,* which has a large contract for towing raw material from the South. Sid. P. Terry is chief engineer of the *John Summers.*

George B. Langin has charge of the engine room of the steamer *Clinton,* which has been engaged to do towing for the Newburgh Dredge Company, which is dredging the Albany basin at Albany, N. Y. The *Clinton* was previously in service on Long Island Sound. Captain Percy Wolfe is the commander.

Captain W. D. Burnham, manager of the American-Hawaiian Steamship Company, New York, retired from active service on November 2. Since Captain Burnham's retirement the office of manager has been discontinued, while the office of superintendent of the line has been created and will be filled by J. D. Tomlinson, formerly assistant to Captain Burnham.

T. W. Spencer will be chief engineer of the new turbine passenger steamship *Great Northern,* just built by the William Cramp & Sons Ship and Engine Building Company, Philadelphia, Pa., for the Spokane, Portland and Seattle Railway Company. The *Great Northern* is a triple-screw, 23-knot ship of 8,255 gross tons, fitted with Parsons turbines and oil-fired watertube boilers. She will run between Astoria, Ore., and San Francisco, Cal.

Charles W. Wall, assistant to the superintending engineer of the Erie Railroad Lake Line, was recently presented by his old associates in the Erie system with an exact half-size replica of the house flags flown by the ships of the Erie fleet. Mr. Wall is one of the best-known marine engineers on the Great Lakes and has been continuously in the service of the Erie Railroad Lake Line since 1867.

Obituary

William H. Olenburg, late treasurer and superintendent of the Ohio Machine & Boiler Company, died October 9 at Cleveland, Ohio.

William B. Bryan, chief engineer of the Metropolitan Water Board, London, died October 28. Mr. Bryan was to have delivered the "Thomas Hawksley" lecture before the Institution of Mechanical Engineers on October 30.

Clarence Williamson, until recently assistant treasurer of Joseph T. Ryerson & Son, Chicago, Ill., died suddenly November 11 at Vincennes, Ind., while on an automobile trip. Mr. Williamson was connected with Joseph T. Ryerson & Son for twenty-five years, and was forced to give up work two years ago on account of ill-health.

Alfred Booth, founder of the Booth line of steamships, died in London November 2. About fifty years ago Booth & Co. was founded by Alfred Booth in partnership with his brother, the Right Honorable Charles Booth, Privy Councillor. The firm is now known as the Booth Steamship Company, Ltd., and is in charge of one of Mr. Booth's sons.

Thomas Congdon, formerly principal surveyor of Lloyd's Register of Shipping in the United States, died recently at Glenridge, N. J., aged eighty-five years. Mr. Congdon entered the shipping industry in 1842 as a shipwright apprentice in the Royal Dockyard at Devonport. He had been connected with Lloyd's Register since January 1, 1856, and served on the staff at Greenock, Bristol and London until 1882, when he was appointed principal surveyor of Lloyd's Register of Shipping in America, where some years ago he was succeeded by Mr. James H. Mancor, who still occupies the position.

Tom R. Davis, mechanical expert of the Flannery Bolt Company, Pittsburgh, died in his sixty-first year at his home, Dravosburg, Pa., on October 12. When eighteen years of age, after a public school education, he began work as a machinist's apprentice with the Allegheny Locomotive Works. In 1875 he secured a fireman's position and the following year was promoted to that of engineer. The following year he entered the employ of the Crosby Gage & Valve Company as special agent. He left that company in 1880 to accept the position of manager of the Monongahela Manufacturing Company at Monongahela City, but later he returned to the employ of the Crosby company, with whom he continued until 1892, when he was employed by the Garlock Packing Company. In 1898 Mr. Davis was employed by the Homestead Manufacturing Valve Company as special expert, leaving that company in 1904 to enter the employ of the Flannery Bolt Company as mechanical expert, which position he held at the time of his death.

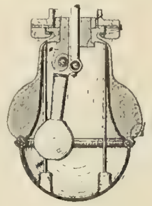
SELECTED MARINE PATENTS

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Millerton, N. Y.

1,112,106. SOUNDER. EDWARD C. WOOD, OF SOMERVILLE, MASS., ASSIGNOR TO SUBMARINE SIGNAL COMPANY, OF WATERVILLE, ME., A CORPORATION OF MAINE.

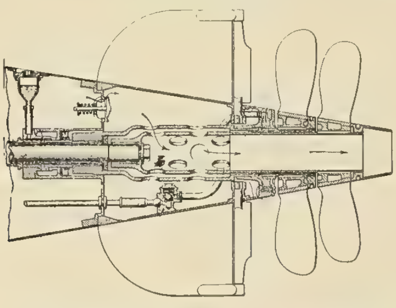
Claim 1.—The sounder above described comprising a bell, a cap having substantially the same diameter as the bell, a gasket, said cap being



clamped to said bell to form an inclosure and said gasket being located between the edges of said cap and said bell whereby it will allow the vibration of the bell and will prevent the leakage of water into the said inclosure. Four claims.

1,108,196. AUTOMOBILE TORPEDO. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

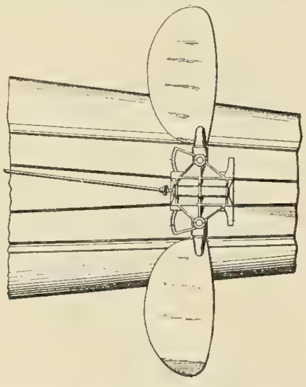
Claim 3.—In an automobile torpedo comprising a compressed air motor, oppositely revolving propeller shafts one within the other, a chamber receiving the exhaust from said motor, an oil-cup having a discharge



duct leading to a bearing, said cup open to the air pressure in said chamber above the oil level for subjecting the oil to pressure to expel it, and a check valve in said oil duct adapted to prevent any back flow of water through said duct into said chamber. Three claims.

1,108,192. SUBMERSIBLE BOAT. GUSTAV M. LAGERGREN, OF NEW LONDON, CONN., ASSIGNOR TO ELECTRIC BOAT COMPANY, A CORPORATION OF NEW JERSEY.

Claim 1.—A submersible vessel having a body, hydroplanes mounted thereon and movable to inoperative positions against the body and to extended positions and a single operating mechanism connected to the



hydroplanes and operable to move them from the inoperative to the extended position and to move them to any desired angular position while in the extended position; substantially as described. Twenty-two claims.

1,112,014. RETARDING DEVICE FOR AUTOMOBILE TORPEDOES. FRANK M. LEAVITT, OF SMITHTOWN, N. Y., ASSIGNOR TO E. W. BLISS COMPANY, OF BROOKLYN, N. Y., A CORPORATION OF WEST VIRGINIA.

Claim 2.—A retarding device comprising a traction bar, two rollers on opposite sides of said bar, gearing for driving one roller for displacing the bar, the bar having a recess in which the other roller may fall, a part the movement of which is to be retarded connected to said latter roller, and an adjustable stop for varying the starting point of said traction bar to adjust the duration of retardation. Three claims.

British patents compiled by G. F. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 10 Gray's Inn Place, W. C., London.

11,540/1913. DETECTING ICEBERGS AT SEA. PROF. DR. F. KRUGER, OF 141 HAUPT STRASSE, LANGFUHR, NR. DANZIG, GERMANY.

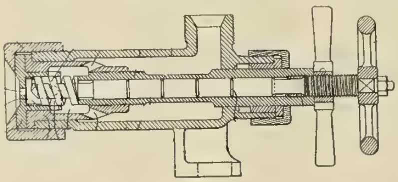
Improved means for detecting icebergs at sea, comprises in combination, a comparatively large spherical or parabolic concave mirror adapted to receive the heat radiated from the iceberg, a surface thermopile, or bolometer, located at a point coinciding with the focal point of the concave mirror and upon which the heat rays are directed, and a movable coil galvanometer, or electro-magnetic Wollaston wire, or like galvanometer connected to the surface thermopile or bolometer.

9292/1913. VENTILATORS FOR SHIPS AND THE LIKE. MECHAN & SONS, LTD., S. MECHON, AND A. J. LEWIS, ALL OF SCOTSTOUN IRON WORKS, GLASGOW.

Claim.—Comprises the construction of a ventilator having a vertical air shaft covered over by a dome, and fittings arranged to form a downwardly extending passage around the exterior of the air shaft, having an inverted valve seating of annular form at its base, arranged so that air may pass through the air shaft to beneath the dome and from thence through the passage past the valve seating to the atmosphere or in the reverse direction, in conjunction with an annular valve adapted to rise under the action of water against the inverted valve seating and close communication between the atmosphere and the air shaft.

13,355/1913. IMPROVEMENTS IN BURNERS FOR LIQUID FUEL. H. E. YARROW, OF YARROW & CO., LTD., OF SCOTSTOUN, GLASGOW.

Claim.—In the construction shown the whirl velocity of the oil or other liquid fuel is varied by varying the width and pitch of the spiral



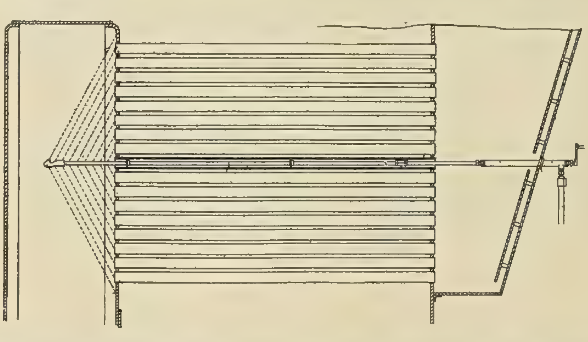
duct through which the oil (preferably heated) is forced under pressure, the duct being formed by the spires of a helical spring which encircles the end of the regulating spindle whereby the rate of fuel consumption is controlled.

11,561/1913. IMPROVEMENTS IN OR RELATING TO MARINERS' COMPASSES OF THE PROJECTOR TYPE. KELVIN & JAMES WHITE, LTD., OF CAMBRIDGE STREET, Glasgow, and M. B. FIELD.

Claim.—A liquid compass of the projector type, the bowl of which is gimballed on an axis located above the plane of the card, the axis of gimballing being spaced from said plane a distance dependent *inter alia* on the index of refraction of the liquid in the bowl, and such as to compensate for error in reading due to rolling of the ship.

14,254/1913. APPARATUS FOR CLEANING SMOKE TUBES OF MARINE AND OTHER MULTI-TUBULAR BOILERS. G. C. DYMOND OF 6 LORD STREET, LIVERPOOL. (COMMUNICATED BY C. H. SHEPLER AND J. W. SHEARER.)

Claim.—The invention consists of a hollow shaft or pipe passed through one of the smoke tubes, and capable of being rotated and, at the same time, slowly advanced longitudinally, is provided at one end beyond the smoke tubes with a blower head projecting radially from the hollow shaft



and adapted when the pipe is rotated to blow obliquely a jet of steam or other pressure fluid first into the tubes nearest to the one through which the hollow shaft is passed, and then by advancing the hollow shaft longitudinally so that the range of the nozzle is increased, and continuing to rotate it, the said nozzle will blow a jet of pressure fluid into all the other smoke tubes in turn, whereby the said smoke tubes or a series of them can be successively cleaned, without changing the centre of rotation, or dismounting any of the parts.

27,287/1913. A DEVICE FOR INCREASING THE EFFICIENCY OF A SCREW PROPELLER. H. HASS, OF 29 ISESTRASSE, HAMBURG, GERMANY.

The combination of a screw propeller with a plurality of fluid directing blades arranged adjacent to and in the path of the water stream flowing on to said propeller and arranged inclined oppositely to the blades of said screw propeller to impart to the current of water a high positive angular velocity in a direction opposite to the direction of rotation of the propeller of such an extent that the said positive velocity is approximately equal to the negative velocity of rotation imparted to the fluid by the screw propeller, so that the slip stream leaving the propeller has substantially zero angular velocity.

INTERNATIONAL MARINE ENGINEERING

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International Marine Engineering

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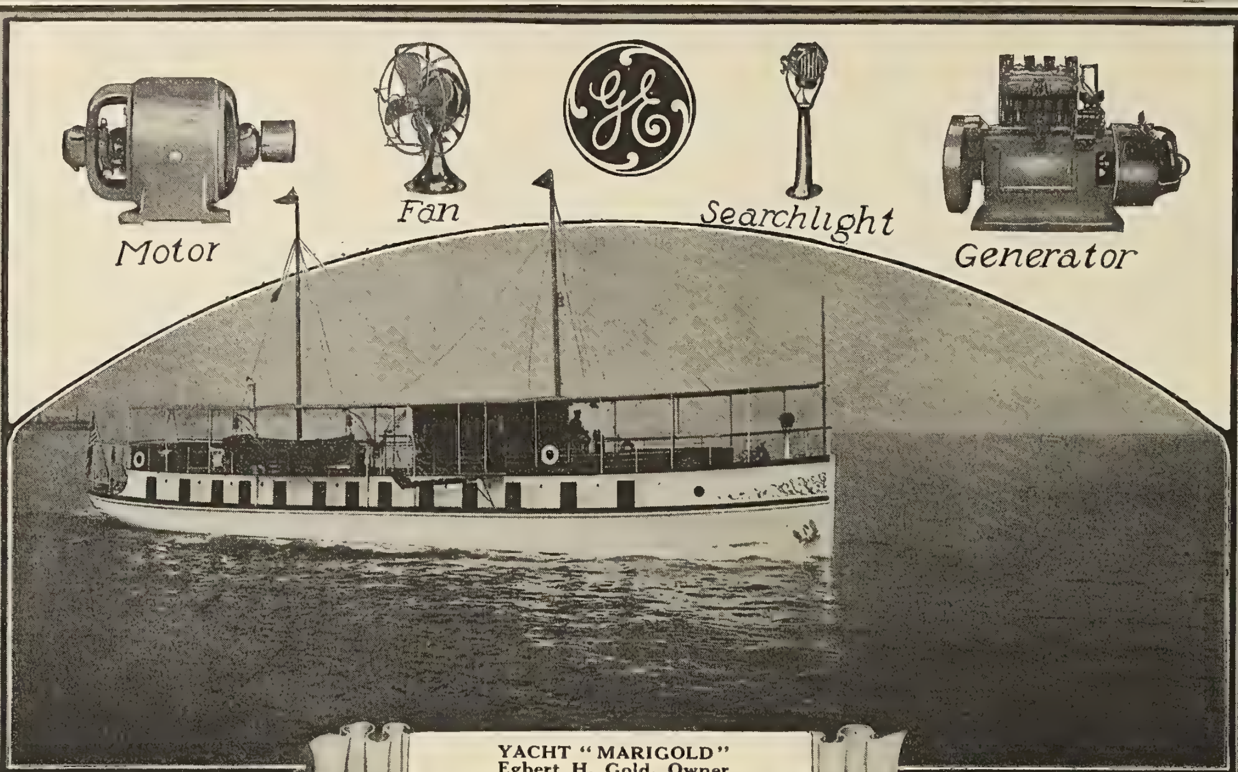
NEW YORK
WHITEHALL BUILDING
17 BATTERY PLACE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 20th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.



YACHT "MARIGOLD"
Egbert H. Gold, Owner
Chicago, Ill.

The "Marigold" is equipped with one 5 horse power G-E Gasolene Electric Generator, one CQ motor for pumping service, a G-E 9-in. marine searchlight, and G-E fans, lamps, etc.

Electric Service on Board Ship

Brilliant illumination, electric heating and cooking devices, electric signals, searchlights and power devices produce greater comfort and safety on board ship.

Edison Mazda Lamps. in all sizes are especially adapted for lighting any part of the boat.

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Electric Cooking and Heating Devices of all kinds can be operated at a cost incomparable with the convenience and simplicity.

Power Motors for the windlass, pumps, etc., can be located conveniently and operated by the turn of a switch.

The Source of Power, most economical and convenient for yachts and motor boats is the G-E Gasolene Engine Generator — a thoroughly reliable direct-connected unit which operates successfully with minimum attention. For vessels having steam, the G-E steam engine generator or turbine may be used.

Bulletin No. 4926 explains and illustrates the applications of electricity in Marine Service. Furnished on request.

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3949

General Electric Company of New York, 83 Cannon Street, London E. C., England

TRADE PUBLICATIONS.

AMERICA

Engineers who keep a file of books for reference will be interested to know that the Joseph Dixon Crucible Company, Jersey City, N. J., still have a limited number of booklets, dealing with such subjects as "Steam Traps," "Unions for Steam Pipes," "Feeding Graphite for Lubricating Purposes," etc., which will be sent free as long as the supply lasts to anyone who cares for them. These treatises were prepared by the well-known engineer Mr. W. H. Wakeman, who has written many articles on practical engineering problems. Numerous illustrations are used to make each subject easily understood.

"Portable Acetylene Lights" is the title of a handsomely printed booklet published by the Alexander Milburn Company, 1420 West Baltimore street, Baltimore, Md. These lights are stated to be especially valuable for use on piers and docks, for loading and unloading ships at night, and for similar purposes. "The Milburn acetylene light is the result of fourteen years' manufacturing experience by the inventors of this class of light, who devote their whole organization to its manufacture and improvement. They have successfully manufactured and sold over 80,000 acetylene generators, both portable and stationary, giving an aggregate of more than 80,000,000 of candlepower, and have never caused a fire or a serious accident. As a result the Milburn light meets the most exacting demands of contractors, railways, industrial plants, the United States Government, fire departments, circuses, hippodromes, life-saving stations and others requiring powerful outdoor illumination. It is used on construction work, in mines and quarries, on steam shovels and dredges, in camps and exhibitions and many other places. It is now recognized as standard and has thousands of satisfied users throughout the United States and Canada and in other countries all over the world."

A "Safety Calendar" has been issued by the National Tube Company, Frick building, Pittsburg, Pa. The company has designed this with the idea of giving it away to every one of its employees, approximating 30,000; the idea being that it will be taken home and hung on the wall, and so be a daily reminder of the "safety" idea. "The 'safety' idea is probably epitomized in the picture shown on the calendar and in the phrase 'Taking No Chances.' This picture was selected out of about a dozen different pictures submitted, and is the product of one of the leading staff artists on *Life*. The picture is copyrighted by the National Tube Company. It will be noted each month bears a separate motto, such mottos being as follows: Every danger sign posted in the mill means that the danger pointed out is real. Men must ascertain what is on these signs around places where they work and give heed to the warnings. The red ball on a sign means danger. It is better to be careful a thousand times than to be injured once. Get the safety habit. If you see a man acting carelessly tell him about it, and don't be afraid of hurting his feelings by doing so. Neglect of slight injuries often results in blood poisoning and serious trouble. The company has provided an emergency hospital, where employees injured in the mill can receive the best of attention. Don't neglect small injuries. Your eyes are valuable to you. Wear goggles when working where chips or sparks may fly. They may be awkward at first, but you will soon get used to them, and then you wouldn't work without them. A dirty mill means accidents. Do not leave waste material or refuse lying around. Places are provided for keeping it. Do your part towards keeping the mill clean. The women and children of an employee's family can be of great help in the safety work by continually urging him to be careful and use safe practices. If he has a slight cut or injury insist that it be dressed promptly at the mill emergency hospital. It is a criminal violation of the law to give or receive money or anything of value in return for a job. The company will rigidly enforce this law. Many employees used to think it was brave to do work in a reckless way and cowardly to be looking out for one's safety. Fortunately such people have become scarce. They are now regarded as fools, and they are discharged when the management finds them out. Reports show that new employees and men engaged in new work are more likely to be injured than old employees. Remember this, and find out the special dangers to be avoided when starting on new work. Your foreman will tell you. The majority of the accidents in the mill are due to some one's carelessness, and frequently to the carelessness of the man himself who is injured. Cultivate safety habits. The company does not want careless men in its employ. Playing, wrestling or fooling on the mill premises, as well as playing or fooling with machinery or tools, is dangerous. Such conduct is strictly prohibited. The careless handling of materials in a steel mill produces more accidents than any other single cause. Remember this when you are moving or handling materials."

Any of our readers interested in boiler graphite should write to the Joseph Dixon Crucible Company, Jersey City, N. J., and ask for Book No. 75, which states fully the advantages of using graphite in marine and stationary boilers.

A patent piston and piston valve packing for reciprocating engines of any make—marine, stationary, steam, gas, water or ammonia—is described by the Lockwood Manufacturing Company, East Boston, Mass., in a catalogue the company has just issued.

Metal filing-cabinets, made especially for use in shipyard drafting rooms, are described in folders published by the Art Metal Construction Company, Jamestown, N. Y. "Drafting rooms, offices and vaults are usually overcrowded. Not enough thought has been given to the safe filing of important drawings, plans, blue prints, plats, etc. After a careful study, the manufacturing skill of the world's largest metal furniture plant has perfected this planfile, built to meet the existing conditions found in the field."

The Portland Company, Portland, Me., has issued Bulletin No. 64 on the subject of wooden towboats. The following statement is made in this bulletin: "Wooden towboats are considered far superior to steel by many authorities. Steel hulls require practically continuous attention with paint and calking tools, and when in need of repairs the ports where such repairs can be made are very limited in number. Wooden hulls, on the other hand, can be repaired almost anywhere on the coast, and can be kept up with so much less care and expense that many large towing concerns will build nothing but wooden towboats."

Blue printing by electric light is the subject of some circulars issued by the Eugene Dietzgen Company, 218 East Twenty-third street, New York. "While blue printing by electric light has eliminated the 'weather-permitting' clause in drafting room calculations, it was not until our latest model electric blue printer was perfected that it was possible to secure a satisfactory machine at a reasonable cost. Our cylindrical self-contained electric blue print machines are adapted for use in small drawing offices as well as large, for they occupy a space of but 3 feet square, and do not require a special operator. Briefly, we want to allude to our extensive line of blue print papers, both prepared and unprepared. With our main and branch houses equipped with the most modern coating rooms, we are prepared to meet your every requirement, and with the utmost despatch."

Electric service on board ship is the subject of Bulletin 4926, published by the General Electric Company, Schenectady, N. Y. Among the electric devices manufactured by the General Electric Company are the following: Edison Mazda Lamps, in all sizes, are especially adapted for lighting any part of the boat. G-E electric fans and electric stateroom heaters provide comforts. The G-E marine searchlight increases the scenic advantages as well as the safety at night. Electric cooking and heating devices of all kinds can be operated at a cost incomparable with the convenience and simplicity. Power motors for the windlass, pumps, etc., can be located conveniently and operated by the turn of a switch. The source of power most economical and convenient for yachts and motor boats is the G-E gasolene engine generator—a thoroughly reliable direct-connected unit which operates successfully with minimum attention. For vessels having steam, the G-E steam engine generator or turbine may be used.

"The Bearing" is the title of a monthly booklet published by the Albany Lubricating Company, 708 Washington street, New York. In connection with the company's statement that the older Albany grease becomes the better it gets, the following instance is cited: "When we moved out of our old factory several years ago there was found among the discarded cups in the cup department an old-style Albany cup that was filled with Albany grease. That style of cup has not been manufactured or in use for the past twenty-five years. From all indications the Albany grease contained in this cup must be twenty-five to thirty years of age, and when examined was found to be in perfect condition. The Albany grease hadn't dried up, it hadn't become rancid nor gummy, it hadn't discolored through oxidation. This instance goes to prove to a great extent our assertion, that the older Albany grease becomes the better it gets. This characteristic of Albany grease works out to the advantage of the purchaser. It permits him to buy in larger quantities. Where a 10-pound can is purchased and used as required, a keg, half-barrel or barrel could be bought at a considerable saving per pound. Many concerns have taken advantage of this fact and are purchasing Albany grease in the wooden packages."

Non-inflammable bulkheads and deck panels are described by the Keyes Products Company, 71 West Twenty-third street New York, in a catalogue the company has just issued. These are said to be water-resistant, light of weight, hard, rigid, and to have splendid tensile strength. Free samples will be sent to anyone interested upon request.

Turbo-fan units for marine work are the subject of Catalogue 210-O, just issued by the B. F. Sturtevant Company, Hyde Park, Mass. These sets are especially made for forced draft work, and the statement is made that the large volume handled by comparatively ssmall units makes them invaluable for marine service, where space is always restricted.

Metal polish for use on board ship is described in a catalogue published by the Hirshe Manufacturing Company, 65 Oliver street, Boston, Mass. This is stated to be a non-explosive, non-settling and non-scratching polish. It is said to contain no acid and to give a brilliant and lasting lustre and to dry quickly.

Ship ventilating thermofans, distillers, evaporators, oil burners, grease extractors, fuel oil burners and other marine specialties are described in a new catalogue just published by the Schutte & Körting Company, Twelfth and Thompson streets, Philadelphia, Pa. This is a valuable catalogue and a copy should be in the hands of every marine man. One will be sent free to any of our readers upon request.

Oil engines of the Diesel type are described in a bulletin published by the Fulton Iron Works, St. Louis, Mo. "The engine is designed to operate on the cheapest petroleum, crude or fuel oils, or tar oils, with greatest reliability and economy, and as ignition is insured by the heat of compression, no hot head, hot plate, electric spark, or other exterior means of ignition is required."

"Booklet IM—The Economy Steam Turbine" is published by the Kerr Turbine Company, Wellsville, N. Y. "From one end of this country to the other, and especially in marine service, 'Economy' turbo-generators are effecting big savings in furnishing light and power for boats and ships of all kinds. The performances of so many 'Economy' turbo-generators are now on record that our engineers can tell you almost to the penny what an installation would do for you."

The Reilly multi-screen feed-water filter and grease extractor is described in Bulletin 607, published by the Griscom-Russell Company, 2124 West Street building, New York. The use of this filter, the catalogue states, guarantees clear water for boilers with the least possible trouble. "The efficiency of a filter depends upon the extent of the filtering area. The Reilly multi-screen has a filtering surface 500 times the cross-sectional area of the feed pipe—much the largest area ever put in so compact a shell."

The Powell "Union" Composite Disk valve is the subject of a folder published by the William Powell Company, Cincinnati, Ohio. "For medium steam pressure, hot water or steam heating the Powell Union composite disk valve embraces the newest and most practical ideas in valve construction. The beveled ground face connection between bonnet and body neck secured by hexagonal union nut, insures an absolutely steam-tight joint under all pressures. The hexagonal union nut can be unscrewed hundreds of times without rounding the corners caused by the wrench slipping. This is an important improvement over the old-style inside thread, red leaded or cemented bonnet, especially on this type of valve, which requires to be taken apart more frequently than a metal disk valve. Stems are packed with a drive gland on stuffing-box on ¾ inch and larger, with plenty of space for packing. Long, full Acme threads on stem, consisting of six threads. These six threads are all in actual use when valve is closed and prevent stripping from too strenuous use. The stem *D* has double forcing collars on its lower end, which engage with the slotted cage *H* that holds the disk *V*. The upper collar prevents the cage from wobbling in opening and closing the valve. The upper face of the top collar also fits against the lower face of the bonnet hub, and allows the valve to be repacked under pressure, wide open. To insert a new disk the cage *H* can be instantly withdrawn by sliding it out from between the collars on the stem. The disk is held in place by disk nut *S*, which can be loosened readily if necessary. No special tools are required in renewing disk. The disk holder is guided to a true axial position by means of guide ribs cast in body shell, ensuring accurate seating of disk in act of closing. The working pressure of the Powell Union composite disk valve is limited to the durability of the rubber disk. The general construction and details of the body, bonnet and trimmings are guaranteed to stand a steam pressure up to 150 pounds."

"Tobin Bronze" is the title of a 32-page booklet published by the American Brass Company, Ansonia, Conn. "We furnish 'Tobin Bronze' in the following forms: Turned and straight pump piston rods and yacht shafting; rolled plates for rudders, centerboards, pump cylinder linings; condenser tube sheets, fin keels and yacht plates, etc.; flat, round, square and hexagonal bars; bars for forgings, boilers and pump linings, bushings, etc."

The Taylor seamless forged steel boiler nozzle, made by the American Spiral Pipe Works, Chicago, Ill., is described in a circular just published by that company. "Forged from a single piece of open-hearth steel without a weld. The safest and most reliable connection between the drum and the piping system. There have been numerous devices for forming the connecting link between the boiler and high-pressure piping, but practically nothing has been produced in keeping with the remainder of the installation, and we believe the use of the Taylor seamless forged steel nozzle is the safest and most reliable connection that can be obtained. The nozzle may be heated and the saddle flange bent to the required circle, with no separate part to become loosened when heated. The saddle flange is of sufficient diameter to enable the use of power riveters for attaching the nozzle."

"Byers' Wrought Iron Pipe" is the subject of a circular just issued by the Bourne-Fuller Company, Cleveland, Ohio. "We recommend Byers' wrought iron pipe because every step in its manufacture, from ore to finished product, is absolutely controlled by the manufacturers; because the pipe is made of the highest grade of wrought iron, refined by puddling the best pig iron, and rolling it into a homogeneous and uniform muck bar and skelp; because no iron or steel scrap is used—only their own pig iron and their own refined iron ever goes into a Byers furnace; because the welding and threading of pipe and couplings are done by the most advanced and accurate methods; because the Byers Company make no 'merchant' or lightweight pipe. It is all guaranteed full weight; because every piece of pipe with its coupling is subjected to a rigid hydrostatic test of 1,500 to 2,000 pounds to the square inch, and thrown out if its shows the slightest defect. Write for prices and booklet, 'The Control of Quality in Every Process.'"

The Columbian Rope Company, Auburn, N. Y., publishes a circular describing its manila rope, which, it is stated, has a long, tough fiber, and can always be trusted. It is said to be especially desirable for towing, rigging and similar marine uses.

"Powell Valves" is the title of a booklet published by the William Powell Company, Cincinnati, Ohio. In the description of the Powell "Union" composite disk valve, the catalogue states: "Observe the bevel ground joint connecting body and bonnet. Red lead or cement is unnecessary to make it tight. Notice the swivel union nut and threads on the outside of the valve body where the steam can't reach them. The valve body outlasts many disks."

TRADE PUBLICATIONS
GREAT BRITAIN

A direct-grip windlass is described in a circular published by Clarke, Chapman & Company, Ltd., Victoria Works, Gateshead-on-Tyne. This is a fully illustrated circular, and all interested in these machines should send for a copy.

The "Clou" Dry Hand Fire Extinguisher, 244 High Holborn, London, W. C., has published some circulars describing this fire extinguishing device, which is stated to be especially valuable for marine use. "Clou fire extinguisher far surpasses any apparatus hitherto invented, by its wonderful combination of powder which had a quintuple effect; by its cone construction, which allows a powerful, regular, wide and distant range of spread; by the simplicity with which it can be handled, even by a child, no knowledge or previous practice being necessary; it is always ready for use; by its property of never failing to act owing to the enormous efficacy of the 'Clou' powder; by the extreme stability of the extinguishing powder, which is affected neither by frost nor heat, for it can be neither frozen nor evaporated; by its perfectly innocuous action, even on the finest and most delicate materials, being easily removable at once without leaving the slightest trace behind; although the best and most efficient, 'Clou' is the cheapest of extinguishing apparatus, the initial cost is the only outlay, fresh powder being supplied gratis after the occurrence of a fire. 'Clou' is of world-wide renown, having been extensively adopted by governing bodies, institutions, theaters, large business establishments, shipping companies, motor companies and others, the accompanying testimonials being the best proof that can be submitted of its efficiency in extinguishing the fiercest fires."

"Wire Falls for Boat Handling" is the title of Bulletin No. 11, published by the Welin Davit & Engineering Company, Ltd., 5 Lloyds avenue, London, E. C. "That recent disasters should be followed by a drastic overhauling of old regulations relating to boat gear was as natural as it had come to be desirable and necessary, and that committees, boards and other bodies should be constituted to consider the subject in detail was an inevitable corollary. The recommendations of the chi f of these committees, viz., the Board of Trade Departmental Committee on Boats and Davits, were issued some little while back, and though still subject to further and final revision, will, at least, as regards the major portion of their contents, probably become before long absolute regulations. If the recommendations relating to the proportion of boat accommodation be upheld, as they almost certainly will be, there will in consequence be many instances where at least two and possibly even more boats will need to be handled by a single set of davits. The committee fully recognized this, and provided for the contingency by stipulating that in such cases a special lowering and hoisting gear should be employed in conjunction with wire falls. It may, therefore, be not altogether without interest to see what is being done in this matter, and we shall endeavor briefly to indicate the chief points of interest in a large and typical modern wire-fall installation, all the gear for which has been designed and is being manufactured and supplied by the Welin Davit & Engineering Company, Ltd., 5 Lloyd's avenue, London, E. C. The vessel we have selected for review is the *Burgermeister O'Swald,* at present under construction for the Hamburg-America Line at the Weser yard. and it is a matter for some little disconcerting reflection that we should have yet again to go abroad to exemplify the first application of a British company's manufactures and designs. True it is that one set of wire gear of the same make has been ordered for one of the more progressive British companies, but otherwise it has been left to our Teutonic neighbors to take—not without much thoughtful pre-experiment—the first plunge by boldly fitting (as described elsewhere) the *Imperator* throughout with Welin davits, wire-fall controls, adjusters, and so on, and to follow up this eminently satisfactory experiment by placing repeat orders for the two huge sister vessels and for six other steamers of the type here illustrated, while the Forenede Damskibs Selskab, of Copenhagen, are fitting their magnificent new liner throughout in like fashion."

"The Isherwood System" is the title of a pamphlet published by J. W. Isherwood, 4 Lloyd's avenue, London, E. C. "Now that there are *272* vessels, aggregating 1,209,336 gross register tons, built or under construction, and shipbuilders already operating the system, the Isherwood system is so firmly established that it should hardly be necessary to explain that this is a compound system, consisting of heavy transverse frames, widely spaced (say 12 feet apart), such frames being slotted to allow longitudinal frames to be passed through them on the whole skin of the ship; that is to say, these fore and aft frames are fitted at close-spaced intervals under the deck and along the sides and along the bottom of the vessel, with intermediate transverse frames in the double bottom to withstand grounding. The transverse and longitudinal frames are joined together by lugs, thus forming a homogeneous framework complete without the shell plating, but which framework, together with the shell plating, provides a girder absolutely unique so far as ship construction is concerned. The extra strength in he case of a vessel of normal dimensions amounts to about 20 percent in the longitudinal direction, and to something like 5 percent to 10 percent in the transverse direction, whilst there is no doubt that this compound system resists torsional stresses in a manner which has never been provided for in the case of vessels build on the old system. It is well at this point to refer to the fact that a practice has been introduced recently of leaving out stringers in the case of vessels built on the old-fashioned system. This has further tended to reduce the resistance of vessels built on the old system to torsional stresses, besides which there is more liability of the vertical frames showing signs of tripping where there is no support from stringers. Whilst discussing this absolutely invaluable feature of added strength, it may be pointed out vessels of various designs where radical departures have been made in the method of distribution of material developed serious defects and have shown structural weakness. Now those who have traced the career of all the Isherwood ships afloat are in a position to state authoritatively that there has been no case of any serious damage through simple stress of weather in the case of a ship built on the Isherwood system; and, moreover, it is a fact that several of these vessels have been badly aground and come off again with little or no damage, and underwriters will probably find that there will be few, if any, total losses from stranding, because the bottom plating is so much better supported, and the deck is so strong

longitudinally that it is very improbable that any ship built on the Isherwood system will break her back."

Accessories, such as non-toppling blocks, gripe gears, boat-lowering capstans, etc., are the subject of Bulletin 15, published by the Welin Davit & Engineering Company, Ltd., 5 Lloyd's avenue, London, E. C. "The various accessories illustrated in this publication are all of standard pattern, and are those usually quoted for. Any reasonable modification, however, can, of course, be made, provided timely notice be given

Dermatine hose and tubing is described by Dermatine Company, Ltd., 93 Neate street, London, S. E., in a catalogue the company has just published. "Dermatine hose for carbonic acid gas is used by some of the principal fire brigades for chemical engines now largely coming into use for dealing with fires promptly at the outset. The lining is made of a special close flexible quality of seamless gray Dermatine, and covered with the best flexible red Dermatine. Guaranteed absolutely reliable for the purpose, and not to perish if kept in use or stock."

The "Vapor" patent scale collector is described by O. N. Beck, 11 Queen Victoria street, London, E. C., in circulars he has just issued. "The advantages of the 'Vapor' collector, for which the fullest guarantee is given, may be summarized as follows: 1. Automatic precipitation of all mineral constituents of the feed water without any chemicals whatsoever, and during working; that is, all the scale-forming substances are rendered insoluble, and are deposited on the apparatus or in the boiler in the form of mud, which is removed by the regular blowing-off of the boiler. Easily soluble salts, such as common salt, remain in solution, and are only precipitated during concentration. The formation of scale of any significance is rendered impossible, so that the cleaning of the boiler becomes an extremely easy and simple matter. 2. Considerable saving of fuel. 3. Greatest saving of the boiler and its mountings, owing to the entire absence of chemicals. 4. Feeding with air-free water, therefore no corrosion. 5. Preheating of the feed water to the normal temperature, ensuring thereby uniform expansion throughout the whole boiler. 6. The 'Vapor' forms a swinging water column within the boiler, having a damping action, so that the noise and the jerks of the feed pipe, and any damage caused thereby to the feed pumps, are obviated. Choking of the feed pipe is guaranteed never to occur. 7. The working mpty of the boiler is rendered absolutely impossible, even in case the feed pumps or return valves fail to operate, as the feeding is effected from the highest point of the boiler."

The subject of cabin boats and davits for life-saving at sea is taken up in Bulletin No. 12, issued by the Welin Davit & Engineering Company, Ltd., 5 Lloyd's avenue, London, E. C. Any one interested should send for a copy of this booklet, in which the matter is fully discussed and from which the following quotation is taken: "The new life-saving appliances rules of the Board of Trade require vessels to be equipped with enough boats and rafts to carry all on board, both passengers and crew. This introduces no new element in cargo boats, which always carried sufficient boats on each side of the vessel to accommodate the crew. But it means a great change for passenger steamers, for it has hitherto not been considered commercially possible to equip them with sufficient boats to carry the immense numbers who cross the ocean in them. The new rules are the result of the public agitation after the loss of the *Titanic,* and for good or ill they have to be obeyed. Whether they are necessary is quite another question. However, since the rules have been made, and have the force of law, shipowners and shipbuilders must conform to them, difficult as this may be. So far the solution of the problem has generally been sought in the use of collapsible boats; but these are, at the best, somewhat of a makeshift, and in future vessels quite different arrangements will have to be adopted. Probably there is no naval architect and but few shipbuilders who are not considering the question, and getting out new plans for stowing and launching boats from steamships. To assist the Board of Trade appointed a departmental committee to advise them (*inter alia*) on the most efficient arrangements for stowing boats on steamships, for launching them in an emergency, and for embarking the passengers and crew; and the Board also asked them for any recommendation which would contribute to the safety of life at sea. The gist of these recommendations is that boats should be stowed side by side on the top deck, parallel to the davits and with mechanical appliances to traverse them, so that they may be brought successively under the davits, and that the present ropes and falls should be replaced by less crude appliances. They further favor the use of much larger decked boats, so large indeed that passengers may be accommodated below deck, and battened down during the process of lowering. Naturally, the committee put forward no schemes as to the actual means by which their recommendations were to be carried out. They left those to engineers and shipbuilders, and already several have been devised. Among these are some by the Welin Davit & Engineering Company, Ltd., of Hopetoun House, Lloyd's avenue, London, E. C."

BUSINESS NOTES

AMERICA

The H. W. Johns-Manville Company, Madison avenue and Forty-first street, New York, manufacturer of insulating and non-conducting materials, states that it has received the contract for the pipe-covering material to be used in the new New York municipal building. This contract involves twenty-seven carloads of material.

A Satisfactory Marine Glue.—L. W. Ferdinand & Company, 201 South street, Boston, Mass., have received the following interesting letter from Mr. Hugh Robinson: "I wish to say that I have always used your Jeffery's marine glue in the construction of motor boats, etc., and have never been able to find another glue which would give the entire satisfaction that it does. In the construction of the hull of the Benoist flying boats, which I designed and built, I always use Jeffery's marine glue exclusively, and they are a marvel of strength and lightness and never leak or take water in the least."

The Toronto branch of the Canadian H. W. Johns-Manville Company, Ltd., announces its removal to more spacious quarters at No. 19 Front street, East. This new store and warehouse has a floor area of approximately 35,000 square feet, and is situated in the heart of the wholesale district. In their new quarters this firm will be able to carry a larger stock and have ample space for the display of their complete line of J-M asbestos roofings, packings, pipe coverings, building materials, electrical and railroad supplies, automobile and plumbing specialties, etc. The entire building will be lighted by their well-known Frink and J-M linolite system of lighting, and one room will be used for exhibiting these systems of lighting.

The Cleveland (Ohio) branch of the H. W. Johns-Manville Company has recently been obliged to provide larger quarters for several of its subsidiary offices. The Columbus office and contract department are now located on the ground floor of the new seven-story fireproof Peters Power building, 45 West Long street, with large warehouse facilities half a block distant. The Toledo office and warehouse have been moved to 213 Water street. This office has just completed a pipe covering, stack lining and cork tiling job in the Second National Bank building, Toledo, which possesses many unique features. Other Cleveland branch sub-offices are located in Akron (717 Second National Bank building); Dayton (259 Fourth Street Arcade), and Youngstown (502 Stambaugh building). Resident representatives are stationed at Lima, Massillon, Greenville and other points in Ohio, also at Huntington and Parkersburg, W. Va. Their work is supplemented by a large corps of traveling men. Last, but not least, the Cleveland branch has just closed a long-term lease for another larger warehouse on Front street, which, when remodeled, will give the branch larger and better storage and shipping facilities than ever.

Strength of Rope.—Of all the factors that enter into the real strength of rope, quality of raw material is most important. The other factors, such as twist, treatment of fiber during manufacture, number of strands, size of yarns, etc., are of secondary importance. Commercially considered, the quality of the raw material is entirely in the hands of the manufacturer. In discussing this subject, *Plymouth Products* states that "In the case of so-called 'Manila' ropes some have shown 50 percent less strength than honest goods of the same size and type of construction. Since the presence of 'doctored' or poor material in rope would be detected only by an expert, the user must of necessity rely upon the maker's reputation. The various twists used on different ropes vary the tensile strength greatly. A soft-laid rope is much stronger than a hard-laid one. Even in ropes made from the same fiber the difference in strength between the two extremes of extra soft and extra hard-laid will amount to 20 percent or more. While strength is a very important requirement in any rope, it is not always the principal one. The sailmaker, for example, wants his rope extra soft-laid for greater ease in handling. The transmission or hoisting requirement—durability under repeated bending—demands the best quality of fiber but not necessarily the highest tensile strength. Consumers should bear such things in mind when judging comparative strengths of different ropes. Between the ropes of reputable makers the strength will be found to vary very little as a result of the treatment of the fiber during the manufacturing processes. The number of strands, and the size of the yarns likewise, affect the strength only slightly, and the particular construction of a rope in these respects is determined rather by some other requirement of its use."

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THE NELSON VALVE COMPANY, Chestnut Hill, Philadelphia, Pa., announces that it has recently taken over the manufacture and sale of the Erwood swing gate valve, formerly made by Walch & Weyth, of Chicago. This valve can be recommended for the following purposes: Back pressure to the atmosphere; atmospheric relief on turbines and condensing engines; safety gate on exhaust lines of pumps, hammers, elevators, etc.; non-return between cylinders and condensers; non-return between open heaters and engines; safety gate on air lines of air compressors; self-cleaning foot valve on suction pump; combined check and gate on discharge of pump. A large number of these valves have already been installed by the leading power houses throughout the United States. In the future the valve will be known as the Nelson-Erwood swing gate valve. Literature is being prepared, and any information wanted in regard to this type of valve will be gladly given by the Nelson Valve Company.

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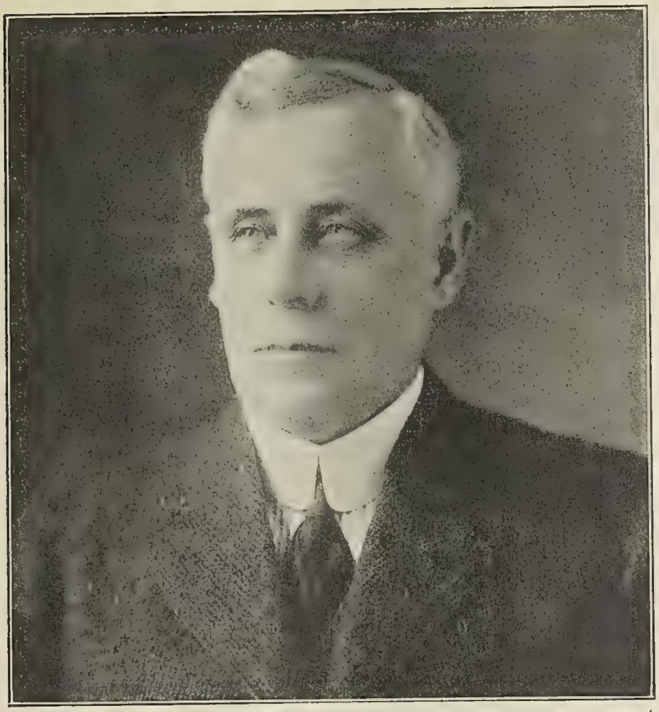

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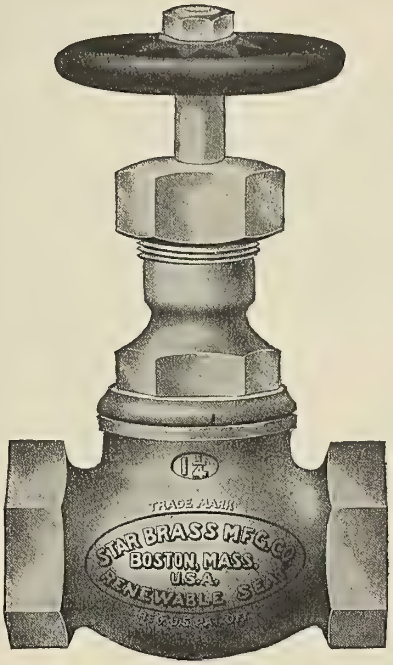

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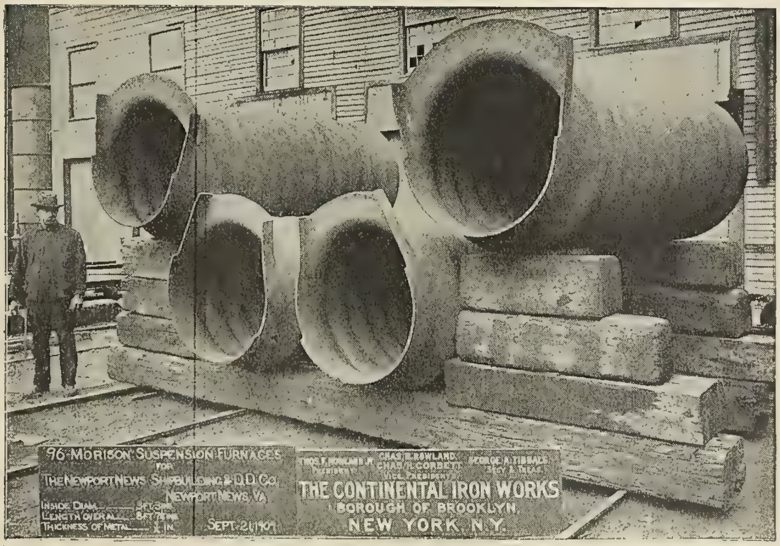

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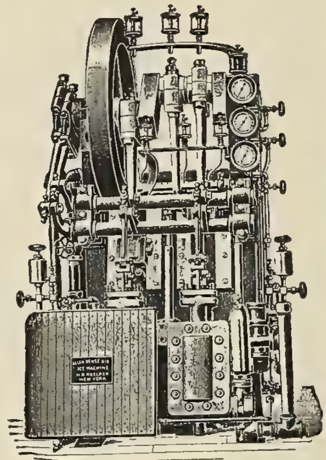

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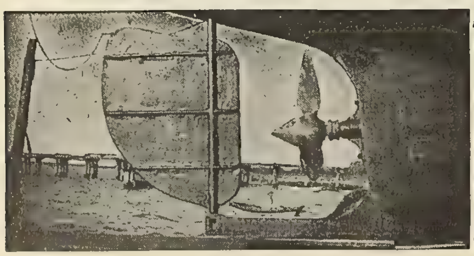

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Decker, Delbert H., Millerton, N. Y.

AUTOMATIC INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.

AUTOMATIC TOWING MACHINES—See TOWING MACHINES.

AUTOMATIC WATER GAUGES—See WATER GAUGES.

BABBITT METAL—See ANTI-FRICTION METAL.

BALL BEARINGS—See THRUST BEARINGS.

BARGES—See SHIPBUILDERS.

BATH TUBS—ENAMELED IRON, PORCELAIN.
Sands, A. B., & Son Co., New York.

BEARINGS—See ANTI-FRICTION METAL; also THRUST BEARINGS.

BELLS.
Hayward, S. F., & Co., New York.
National Tube Co., Pittsburg, Pa.

BELTING—Also see RUBBER BELTING.
New York Belting & Packing Co., New York.

BENCH TOOLS.
Starrett, L. S., Co., Athol, Mass.
Williams & Co., J. H., Brooklyn, N. Y.

BENDING MACHINES, KEEL PLATE OR GARBOARD.
Niles-Bement-Pond Co., New York.

BENDING ROLLS—See ROLLS.

BILGE PUMPS—Also see PUMPS.
Edwards Manufacturing Co., Cincinnati, Ohio.

BINNACLES.
Hand, John E., & Sons Co., Philadelphia, Pa.

BITTS
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

BLOWERS.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

BLOW-OFF VALVES—See VALVES.

BLOWERS, SOOT—See SOOT BLOWERS.

BOAT ACCESSORIES.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

BOAT BUILDERS—See LAUNCHES AND YACHTS.

BOAT DAVITS—See DAVITS.

BOATS—See LIFE BOATS; also LAUNCHES AND YACHTS.

BOAT FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

BOILERS—Also see ENGINE BUILDERS—also SHIP BUILDERS.
Almy Water Tube Boiler Co., Providence, R. I.
Babcock & Wilcox Co., New York.
Bath Iron Works, Bath, Maine.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Roberts Safety Water Tube Boiler Co., Red Bank, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

BOILER CIRCULATORS.
Eckliff Automatic Boiler Circulator Co., Detroit, Mich.
Ross Schofield Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

BOILER COMPOUNDS.
Johns-Manville, H. W., Co., New York.

BOILER COVERING—See NON-CONDUCTING COVERING.

BOILER FEEDERS—See FEED-WATER REGULATORS.

BOILER-FLUE AND TUBE CLEANERS.
Griscom-Russell Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER FLUE AND TUBE CUTTERS.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

BOILER AND PIPE COVERINGS—See NON-CONDUCTING COVERING.

BOILER ROOM FITTINGS.
American Blower Co., Detroit, Mich.
Ashton Valve Co., Boston, Mass.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Leavitt Machine Co., Orange, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Nelson Valve Co., Philadelphia, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

BOILER STAYBOLTS—See STAYBOLTS.

BOILER TUBES.
National Tube Co., Pittsburg, Pa.

BOILER TUBE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

BOILER TUBE RETARDERS.
Griscom-Russell Co., New York.

BOLTS AND NUTS.
National Tube Co., Pittsburg, Pa.

BORING BARS—See CYLINDER BORING BARS.

BORING MACHINES—METAL WORKING.
Niles-Bement-Pond Co., New York.

BORING MACHINES—WOOD.
Independent Pneumatic Tool Co., Chicago and New York.

BORING AND TURNING MILLS.
Niles-Bement-Pond Co., New York.

BRASS CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Nelson Valve Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

BRASS FITTINGS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Nelson Valve Co., Philadelphia, Pa.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

BRAZING MATERIALS.
Smooth-On Mfg. Co., Jersey City, N. J.

BRONZE.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

BRONZE CASTINGS—See CASTINGS, BRONZE.

BUOYS.
Sands, A. B., & Son Co., New York.

BUOYS, LIGHT—See LIGHT BUOYS.

BUOYS, RING.
Ferdinand, L. W., & Co., Boston, Mass.

BURNERS, FUEL OIL—See FUEL OIL BURNERS.

BUSHINGS.
National Tube Co., Pittsburg, Pa.

BUTTERFLY VALVES—See VALVES.

BY-PASS VALVES—See VALVES.

CABLES—See CHAIN, also ROPE.

CABLEWAYS—See MARINE CABLEWAYS.

CALORIMETERS—SEPARATING, THROTTLING, COAL.
Schutte & Körting Co., Philadelphia, Pa.

CANOE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

CAPSTANS—STEAM—ELECTRIC—HAND.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

CARBONIC ICE MACHINES.
Kroeschell Bros. Ice Machine Co., Chicago, Ill.

CASTINGS—BRONZE—Also see STEEL CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

CEMENT-ASBESTOS.
Johns-Manville, H. W., Co., New York.

CEMENT-LINOLEUM.
Ferdinand, L. W., & Co., Boston, Mass.

CENTRIFUGAL PUMPS—See PUMPS.

CHAIN.
Standard Chain Co., Pittsburg, Pa.
Weimer Chain & Iron Co., Lebanon, Pa.

CHAIN HOISTS.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Ford Chain Block & Mfg. Co., Philadelphia.

CHAIN PIPE WRENCHES—See WRENCHES.

CHAIN STOPPERS.
American Engineering Co., Philadelphia, Pa.

CHANDLERY STORES.
Boyle, John, & Co., Inc., New York.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Russell Co., New York.
Hand, John E., & Sons Co., Philadelphia, Pa

CHECK VALVES—See VALVES.

CHRONOMETERS—See CLOCKS.

CHOCKS.
American Engineering Co., Philadelphia, Pa.

CHUCKS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CIRCULATING PUMPS—See PUMPS.

CIRCULATORS—See BOILER CIRCULATORS.

CLASSIFICATION ASSOCIATION.
American Bureau of Shipping, New York.

CLOCKS.
Ashton Valve Co., Boston, Mass.
Star Brass Mfg. Co., Boston, Mass.

COAL.
Pocahontas Fuel Co., New York.

COAL HANDLING MACHINERY.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Chicago, Ill.

COATINGS, ANTI-RUST—See ANTI-RUST COATINGS.

COCKS—See GAUGE COCKS.

COLLECTORS—PNEUMATIC.
Sturtevant Co., B. F., Hyde Park, Mass.

COMPANION FLANGES.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.

COMPASSES.
Hand, John E., & Sons Co., Philadelphia, Pa.

COMPOUNDS—See BOILER COMPOUNDS.

CONDENSERS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Davidson, M. T., Co., New York.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

CONSULTING ENGINEERS—See ENGINEERS—Also PROFESSIONAL CARDS.

CONVEYING MACHINERY.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Chicago, Ill.
Otis Elevator Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

COOLERS, AIR—See AIR COOLERS.

COOLERS FOR OIL.
Schutte & Körting Co., Philadelphia, Pa.

COPPER—See BRASS AND COPPER.

CORDAGE—Also see ROPE and WIRE ROPE—Also TWINE.
Columbian Rope Co., Auburn, N. Y.
Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Plymouth Cordage Co., North Plymouth, Mass.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

CORK CEMENT, FENDERS, JACKETS, RINGS.
Ferdinand, L. W., & Co., Boston, Mass.

CORRUGATED FURNACES.
Continental Iron Works, Brooklyn, N. Y.

COTTON DUCK—See DUCK.

COTTON RUBBER-LINED HOSE—See HOSE.

COUNTERS—See REVOLUTION COUNTERS.

COVERING, STEAM—See NON-CONDUCTING COVERING.

CRANES.
American Engineering Co., Philadelphia, Pa.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Niles-Bement-Pond Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

CRANK SHAFTS—See FORGINGS.

CUTTERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

CYLINDER BORING BARS.
Niles-Bement-Pond Co., New York.

CYLINDER RELIEF VALVES—See VALVES.

CYLINDERS FOR COMPRESSED AIR, GAS, ETC.
National Tube Co., Pittsburg, Pa.

DAMPER REGULATORS.
Diamond Power Specialty Co., Detroit, Mich.

DAVITS.
Welin Marine Equipment Co., Long Island City, N. Y.

DECK HOISTS—See HOISTING ENGINES.

DECK PLATES.
Sands, A. B., & Son Co., New York.

DECK PUMPS—See PUMPS.

DIAPHRAGM PUMPS—See PUMPS.
Hyde Windlass Co., Bath, Maine.

DIES.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DIRECT-CONNECTED SETS—See ELECTRICAL PLANTS.

DIRECTION AND REVOLUTION INDICATORS.
McNab Co., The, Bridgeport, Conn.

DISENGAGING GEARS.
Welin Marine Equipment Co., Long Island City, N. Y.

DISTILLERS—See EVAPORATORS.

DIVING APPARATUS.
Morse, Andrew J., & Son, Inc., Boston, Mass.
Schrader's Son, Inc., A., New York.

DRAFT, MECHANICAL—See MECHANICAL DRAFT.

DRAFT GAUGES.
McNab Co., The, Bridgeport, Conn.

DRAFTING INSTRUMENTS.
Starrett, L. S., Co., Athol, Mass.

DRAIN VALVES—See VALVES.

DREDGE ENGINES.
American Engine & Electric Co., Bound Brook, N. J.

DREDGING MACHINERY.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.

DRILLING MACHINES, VERTICAL, HORIZONTAL AND RADIAL.
Niles-Bement-Pond Co., New York.

DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

DRILLS, ELECTRIC—See ELECTRIC DRILLS.

DRILLS, PNEUMATIC—See PNEUMATIC TOOLS—Also AIR DRILLS

DRILLS, PORTABLE—See PORTABLE DRILLS.

DROP FORGINGS—EYE BOLTS, HOOKS, ROPE SOCKETS, WRENCHES, ETC.
Williams & Co., J. H., Brooklyn, N. Y.

DROP HAMMERS.
Niles-Bement-Pond Co., New York.

DRY DOCKS AND MARINE RAILWAYS.
Krajewski-Pesant Corporation, Havana, Cuba.
Merrill-Stevens Co., Jacksonville Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va
Tietjen & Lang Dry Dock Co., Hoboken, N. J.

DRY DOCKS—MARINE RAILWAY—MANUFACTURER.
Crandall Engineering Co., The, East Boston, Mass.

DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DUCK.
Boyle, John, & Co., Inc., New York.

DYNAMOS—See ELECTRIC PLANTS; also STEAM TURBINE DYNAMOS.

ECONOMIZERS, FUEL—See FUEL ECONOMIZERS.

EJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ELECTRIC DRILLS.
General Electric Co., Schenectady, N. Y.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville, H. W., Co., New York.

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
American Engineering Co., Philadelphia, Pa.
Brown Hoisting Machinery Co., Cleveland, Ohio.
General Electric Co., Schenectady, N. Y.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.

ELECTRIC LIGHTS.
General Electric Co., Schenectady, N. Y.

ELECTRIC PLANTS.
Gas Engine & Power Co., and Chas. L. Seabury & Co., Consol., Morris Heights, N. Y.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ELECTRICAL FITTINGS AND SUPPLIES—Also see ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.

ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

ELEVATORS, FREIGHT—See FREIGHT ELEVATORS, also INCLINED ELEVATORS.

ENGINE PACKING—See PACKING.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING AND CONTRACTORS.
American Engineering Co., Philadelphia, Pa.
Donnelly, W. T., New York.
Griscom-Russell Co., New York.
Hough, Edward S., San Francisco, Cal.
Whitaker, Morris M., Nyack, N. Y.

ENGINES FOR AUXILIARIES.
Alberger Pump and Condenser Co., New York.
American Blower Co., Detroit, Mich.
American Engine and Electric Co., Bound Brook, N. J.
American Engineering Co., Philadelphia, Pa.
De Laval Steam Turbine Co., Trenton, N. J.
Hyde Windlass Co., Bath, Maine.
Kerr Turbine Co., Wellsville, N. Y.
Marine Iron Works, Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES, OIL—See also DIESEL ENGINES.
Mietz, A., New York.

ENGINES—PROPELLING.
Bath Iron Works, Bath, Maine.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Kingsford Foundry & Machine Works, Oswego N. Y.
Marine Iron Works, Chicago, Ill.
Mietz, A., New York.
Parsons Marine Steam Turbine Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Ward, Chas., Engineering Works, Charleston, W. Va.

ENGINE-ROOM CLOCKS—See CLOCKS.

ESCALATORS.
Otis Elevator Co., New York.

EVAPORATORS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Davidson, M. T., Co., New York.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

EXCESS PUMP GOVERNORS—See PUMP GOVERNORS.

EXHAUST FANS—See BLOWERS.

EXHAUST HEADS.
Sturtevant Co., B. F., Hyde Park, Mass.

EXPANDERS—See BOILER FLUE AND TUBE EXPANDERS.

EXPANSION JOINTS.
Alberger Pump and Condenser Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.

FANS—See BLOWERS.

FEED CHECK VALVES—See VALVES.

FEED-WATER HEATERS AND PURIFIERS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FEED-WATER REGULATORS.
Alberger Pump and Condenser Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.

FERRY BOAT LAMPS—See LAMPS.

FILES.
Nicholson File Co., Providence, R. I.

FILTERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FIRE DEPARTMENT SUPPLIES.
Fumigating & Fire Extinguishing Co. of America, New York.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE EXTINGUISHERS.
Fumigating & Fire Extinguishing Co. of America, New York.
Hayward, S. F., & Co., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE HOSE—See HOSE.

FIREPROOF CONSTRUCTION.
Johns-Manville, H. W., Co., New York.
Keyes Products Co., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

FLANGES.
- Dart, E. M., Mfg. Co., Providence, R. I.
- Lunkenheimer Co., Cincinnati, Ohio.
- National Tube Co., Pittsburg, Pa.
- Williams Valve Co., D. T., Cincinnati, Ohio.

FLANGING PRESSES.
- Niles-Bement-Pond Co., New York.

FLEXIBLE SHAFTING.
- Stow Mfg. Co., Binghamton, N. Y.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
- American Blower Co., Detroit, Mich.
- De Laval Steam Turbine Co., Trenton, N. J.
- General Electric Co., Schenectady, N. Y.
- Sturtevant Co., B. F., Hyde Park, Mass.

FORGES.
- Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
- Hyde Windlass Co., Bath, Me.

FREIGHT ELEVATORS FOR DOCKS AND WHARVES.
- Otis Elevator Co., New York.

FREIGHT-HANDLING EQUIPMENT.
- Brown Hoisting Machinery Co., Cleveland, Ohio.
- Link-Belt Co., Chicago, Ill.
- Otis Elevator Co., New York.

FRIGIDOMETERS.
- McNab Co., The, Bridgeport, Conn.

FROSTPROOF COVERINGS.
- Ferdinand, L. W., & Co., Boston, Mass.

FUEL ECONOMIZERS.
- Griscom-Russell Co., New York.
- Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
- Schutte & Körting Co., Philadelphia, Pa.

FURNACES—Also see CORRUGATED FURNACES.
- Continental Iron Works, New York.

FUSIBLE PLUGS.
- Griscom-Russell Co., New York.
- Lunkenheimer Co., Cincinnati, Ohio.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
- American Blower Co., Detroit, Mich.
- Schutte & Körting Co., Philadelphia, Pa.
- Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
- Griscom-Russell Co., New York.
- Johns-Manville, H. W., Co., New York.
- Katzenstein & Co., L., New York.
- New York Belting & Packing Co., New York.
- Peerless Rubber Mfg. Co., New York.
- Smooth-On Mfg. Co., Jersey City, N. J.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS. KEROSENE ENGINES; OIL ENGINES; DIESEL ENGINES.
- Bridgeport Motor Co., Bridgeport, Conn.
- Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
- Mietz, A., New York.
- Standard Motor Construction Co., Jersey City, N. J.

GAS ENGINE SPECIALTIES.
- Lunkenheimer Co., Cincinnati, Ohio.
- Nelson Valve Co., Philadelphia, Pa.
- Powell, Wm., Co., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GAS PRODUCERS—See MARINE GAS PRODUCERS.

GATE VALVES—See VALVES.

GAUGE COCKS.
- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- National Tube Co., Pittsburg, Pa.
- Nelson Valve Co., Philadelphia, Pa.
- Powell, Wm., Co., Cincinnati, Ohio.
- Star Brass Mfg. Co., Boston, Mass.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGES—See STEAM GAUGES; also WATER GAUGES.

GAUGE GLASSES.
- Jerguson Gage & Valve Co., Boston, Mass.
- Lunkenheimer Co., Cincinnati, Ohio.
- Williams Valve Co., D. T., Cincinnati, Ohio.

GENERATORS—See ELECTRIC PLANTS.

GLOBE VALVES—See VALVES.

GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

GONGS.
National Tube Co., Pittsburg, Pa.

GOVERNORS—See PUMP GOVERNORS.

GRABS—See DREDGING MACHINES.

GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

GRATE BARS.
Griscom-Russell Co., New York.

GREASE—See LUBRICANTS.

GREASE CUPS—See LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

GREASE EXTRACTORS.
Griscom-Russell Co., New York.

GYPSEYS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.

HARDWARE—See MARINE HARDWARE; also CHANDLERY STORES.

HARDWOOD—See LUMBER.

HAWSERS—See WIRE ROPE.

HEATERS—BATH, LAVATORY, SHOWER.
Alberger Pump and Condenser Co., New York.
Sands, A. B., & Son Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

HEATING AND VENTILATING APPARATUS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

HELMETS, SMOKE AND AMMONIA.
Hayward, S. F., & Co., New York.

HEMP—See TWINE.

HOISTING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.

HOISTS, CHAIN—See CHAIN HOISTS.

HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
Eureka Fire Hose Mfg. Co., New York.
Hayward, S. F., & Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
New York Belting & Packing Co., New York.

HOSE COUPLING.
Eureka Fire Hose Co., New York.
Hayward, S. F., & Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
Hayward, S. F., & Co., New York.
Morse, Andrew J., Son, Inc., Boston, Mass.

HOSE REELS AND RACKS.
Hayward, S. F., & Co., New York.

HUMIDIFIERS.
Griscom-Russell Co., New York.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.

ICE DETECTORS.
McNab Co., The, Bridgeport, Conn.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE—Also see DIRECTION AND REVOLUTION INDICATORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., New York.

IRON CEMENT.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Mietz, A., New York.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES.
Bridgeport Motor Co., Bridgeport, Conn.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE GUNS.
Hayward, S. F., & Co., New York.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Hayward, S. F., & Co., New York.
Welin Marine Equipment Co., Long Island City, N. Y.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOG REGISTERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

LUMBER.
Vrooman, S. B., Co., Philadelphia, Pa.

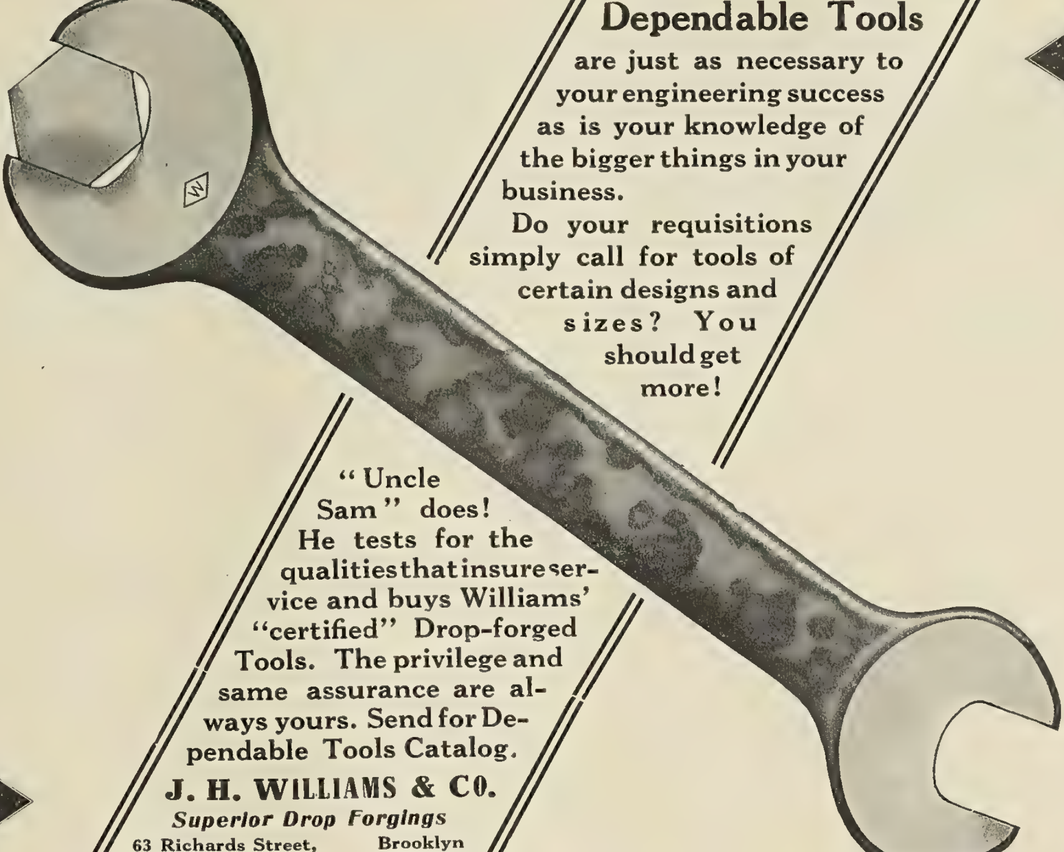
LUMBER—FIREPROOF.
Keyes Products Co., New York.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.
MANILA AND SISAL ROPE—See ROPE; also CORDAGE.
MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.
MARINE CABLEWAYS.
Lidgerwood Mfg. Co., New York.
MARINE ENGINES—See ENGINES, PROPELLING.
MARINE FORGINGS—See FORGINGS.
MARINE GAS PRODUCERS.
Griscom-Russell Co., New York.
Marine Producer Gas Power Co., New York.
MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.
MARINE HARDWARE.
Griscom-Russell Co., New York.
Ferdinand, L. W., & Co., Boston, Mass.
MARINE LAMPS—See LAMPS.
MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.
MARINE RANGES—See RANGES.
MARINE REFRIGERATION—See REFRIGERATING PLANTS.
MARINE SIGNALS—See SIGNALS.
MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.
MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.
MEGAPHONES—See CHANDLERY STORES.
METAL POLISH
Hirshe Manufacturing Co., Boston, Mass.
METAL WORKING TOOLS—See TOOLS, MACHINE.
METALLIC PACKING—Also see PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
United States Metallic Packing Co., Philadelphia, Pa.
METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.
MILLING MACHINES.
Niles-Bement-Pond Co., New York.
MINERAL WOOL—See NON-CONDUCTING COVERING
MONITOR NOZZLES—See HOSE NOZZLES.
MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
MOTOR BOATS—See LAUNCHES AND YACHTS.
MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.
MOTORS, GASOLINE—See GASOLINE ENGINES.
MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.
MULTI-SPEED MOTORS.
Stow Mfg. Co., Binghamton, N. Y.
NAUTICAL INSTRUMENTS.
Hand, John E., & Sons Co., Philadelphia, Pa.
NAVAL ARCHITECTS—See PROFESSIONAL CARDS.
NEEDLE VALVES—See VALVES.
NIPPLES.
National Tube Co., Pittsburg, Pa.
NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.
NOZZLES—See HOSE NOZZLES.
NUTS—See BOLTS AND NUTS.
OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.
OIL—See LUBRICANTS.
OIL BURNERS, FUEL—See FUEL OIL BURNERS.
OIL CUPS—See LUBRICATORS.
OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.
OIL ENGINES—See ENGINES, OIL.
OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
ORE DOCKS—See DOCKS.



PACKING—Also see METALLIC PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
Peerless Rubber Mfg. Co., New York.

PACKING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

PILING—STEEL.
Lackawanna Steel Co., Buffalo, N. Y.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
Dart. E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell Co., The, Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.

PLANIMETERS.
Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
Davidson, M. T., Co., New York.
Sands, Alfred B., & Son Co., New York.

PNEUMATIC SEPARATORS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

PNEUMATIC TOOLS—Also see AIR COMPRESSORS.
Independent Pneumatic Tool Co., Chicago and New York.

POPPET VALVES—See VALVES.

PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.

PORTABLE DRILLS.
General Electric Co., Schenectady, N. Y.
Stow Mfg. Co., Binghamton, N. Y.

POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.

PRESSURE REGULATORS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

PRODUCERS—See MARINE GAS PRODUCERS.

PROFESSIONAL CARDS.
Cox & Stevens, New York.
Decker, Delbert H., Millerton, N. Y.
Donnelly, W. T., New York.
Hough, Edward S., San Francisco, Cal.
Whitaker, Morris M., Nyack-on-Hudson, N. Y.

PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
Donnelly, W. T., New York.
Hyde Windlass Co. Bath, Me.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPS.
Alberger Pump and Condenser Co., New York.
Davidson, M. T., Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Edwards Manufacturing Co., Cincinnati, Ohio.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Sands, A. B., & Son Co., New York.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, BILGE—See BILGE PUMPS.

PUMPS, DREDGING.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULIC POWER AND HAND.
Niles-Bement-Pond Co., New York.

PYROMETERS.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

RANGES.
Sands, A. B., & Son Co., New York.

RASPS.
Nicholson File Co., Providence, R. I.

REAMERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

RECORDING COMPASSES.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

REDUCING VALVES—See VALVES.

REFLEX WATER GAUGES.
Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING.

REFRIGERATING MACHINERY.
Brunswick Refrigerating Co., New Brunswick, N. J.
Johns-Manville Co., H. W., New York.
Kroeschell Bros. Ice Machine Co., Chicago, Ill.
Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

RESEATING MACHINES—See VALVE RESEATING MACHINES.

REVOLUTION COUNTERS.
Ashton Valve Co., Boston, Mass.
McNab Co., The, Bridgeport, Conn.

RHEOSTATS.
General Electric Co., Schenectady, N. Y.
Simplex Electric Heating Co., Cambridge, Mass.

RIGGING—See WIRE ROPE.

RIVER BOATS—Also see SHIPBUILDERS AND DRY DOCK COS.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Marine Iron Works, Chicago, Ill.
Merrill-Stevens Co., Jacksonville, Fla.
Ward, Chas., Engineering Works, Charleston, W. Va.

RIVETING MACHINES, HYDRAULIC AND STEAM POWER.
Independent Pneumatic Tool Co., Chicago and New York.
Niles-Bement-Pond Co., New York.

RIVETERS, PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

ROLLER BEARINGS—See THRUST BEARINGS.

ROLLS, BENDING AND STRAIGHTENING.
Niles-Bement-Pond Co., New York.

ROOFING PAINTS.
Ferdinand, L. W., & Co., Boston, Mass.

ROPE—Also see WIRE ROPE, TRANSMISSION ROPE, and MANILA AND SISAL ROPE.
Columbian Rope Co., Auburn and New York.
Durable Wire Rope Co., Boston, Mass.
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.
Plymouth Cordage Co., North Plymouth, Mass.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

ROTARY BLOWERS—See BLOWERS.

ROWBOATS—See LAUNCHES AND YACHTS.

RUBBER BELTING.
Hayward, S. F., & Co., New York.

RUBBER GOODS—Also see Packing—Also see INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
Hayward, S. F., & Co., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.

RUBBER MATTING CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

RUBBER TILING—See INTERLOCKING RUBBER TILING.

RUBBER VALVES—See VALVES, RUBBER.

SAFETY VALVES—See VALVES.

SANITARY FITTINGS—See PLUMBING.

SANITARY PUMPS—See PLUMBING.

SEARCHLIGHTS.
Carlisle & Finch Co., Cincinnati, Ohio.
General Electric Co., Schenectady, N. Y.

SENTINEL VALVES—See VALVES.

SEPARATORS—PNEUMATIC—See PNEUMATIC SEPARATORS

SHAFTING—HOLLOW, SEAMLESS STEEL.
National Tube Co., Pittsburg, Pa.

SHAFT STEEL—See STEEL SHAFTING.

SHALLOW-DRAFT RIVER BOATS—See RIVER BOATS. Also SHIPBUILDERS AND DRY DOCK COMPANIES.

SHEARING MACHINES, HYDRAULIC, STEAM POWER AND HAND.
Niles-Bement-Pond Co., New York.

SHEATHING METAL—See YELLOW METAL; also BRASS AND COPPER.

SHEETING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

SHIPBUILDERS AND DRY DOCK COMPANIES—See also RIVER BOATS.
Bath Iron Works, Bath, Maine.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Corporation, Quincy, Mass.
Gas Engine & Power Co., & Chas. L. Seabury & Co., Consol., Morris Heights, New York.
Krajewski-Pesant Corporation, Havana, Cuba.
Marine Iron Works, Chicago, Ill.
Marvel, T. S., Shipbuilding Co., Newburg, N. Y.
Merrill-Stevens Co., Jacksonville, Fla.
Newport News Shipbuilding & Dry Dock Co., Newport News, Va.
Seattle Construction & Dry Dock Co., Seattle, Wash.
Tietjen & Lang Dry Dock Co., Hoboken, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.

SHIP CHANDLERS—See CHANDLERY STORES.

SHIP ELEVATORS—See MARINE ELEVATORS.

SHIP FITTINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Griscom-Russell Co., New York.

SHIP GLUE—See MARINE GLUE.

SHIP LOGS AND SPEED INDICATORS.
Nicholson Ship Log Co., Cleveland, Ohio.
Schuette Recording Compass Co., Manitowoc, Wis.

SHIP STORES—See CHANDLERY STORES.

SHIPYARDS—See SHIPBUILDERS.

SHOWER BATHS—See PLUMBING.

SLOTTING MACHINES.
Niles-Bement-Pond Co., New York.

SMOOTH-ON.
Smooth-On Mfg. Co., Jersey City, N. J.

SOOT BLOWERS.
Diamond Power Specialty Co., Detroit, Mich.

SOUNDING MACHINES.
Hand, John E., & Sons Co., Philadelphia, Pa.

SPEED INDICATORS FOR SHIPS, YACHTS AND MOTOR BOATS.
Schuette Recording Compass Co., Manitowoc, Wis.

STEAM ENGINE INDICATORS—See INDICATORS.

STEAM ENGINES—See ENGINES.

STEAM GAUGES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM HAMMERS.
Niles-Bement-Pond Co., New York.

STEAM AND HOT-BLAST APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

STEAM PUMPS—See PUMPS.

STEAM SEPARATORS.
Griscom-Russell Co., New York.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM SPECIALTIES.
Alberger Pump and Condenser Co., New York.
American Blower Co., Detroit, Mich.
Ashton Valve Co., Boston, Mass.
Diamond Power Specialty Co., Detroit, Mich.
Griscom-Russell Co., New York.

Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., New York.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

STEAM SUPERHEATERS.
Babcock & Wilcox Co., New York.

STEAM TRAPS.
American Blower Co., Detroit, Mich.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Griscom-Russell Co., New York.
National Tube Co., Pittsburg, Pa.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.
Williams Valve Co., D. T., Cincinatti, Ohio.

STEAM TURBINES.
Alberger Pump and Condenser Co., New York.
Bath Iron Works, Bath, Maine.
De Laval Steam Turbine Co., Trenton, N. J.
Fletcher, W. & A., Co., Hoboken, N. J.
Fore River Shipbuilding Corporation, Quincy, Mass.
General Electric Co., Schenectady, N. Y.
Kerr Turbine Co., Wellsville, N. Y.
Parsons Marine Steam Turbine Co., New York.
Terry Steam Turbine Co., Hartford, Conn.

STEAM TURBINE DYNAMOS.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.

STEAMERS, LIGHT-DRAFT, RIVER—See RIVER BOATS.

STEEL BALLS.
Bantam Anti-Friction Co., Bantam, Conn.

STEEL SHEET PILING.
Lackawanna Steel Co., Buffalo, N. Y.

STEEL VALVES—See FORGED STEEL VALVES.

STEERING GEARS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STEERING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.

STEERING WHEELS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

STOP COCKS—See VALVES.

STOVES—See RANGES.

STRAIGHTENING ROLLS—See ROLLS.

SUPERHEATERS—See STEAM SUPERHEATERS.

SUPERHEATER TUBES.
National Tube Co., Pittsburg, Pa.

SURFACE CONDENSERS—See CONDENSERS.

SWITCHBOARDS—See ELECTRICAL INSTRUMENTS.

TACKLE BLOCKS—See BLOCKS.

TANKS—COPPER, GALVANIZED IRON.
Griscom-Russell Co., New York.
Sands, A. B., & Son Co., New York.

TEAK—See LUMBER.

TEMPLATE BOARDS.
Fay Manilla Roofing Co., Camden, N. J.

THERMOMETERS—FOR EVERY PURPOSE.
H. & M. Division of the Taylor Instrument Cos., Rochester, N. Y.

THERMIT WELDING.
Goldschmidt Thermit Co., New York.

THREADING AND CUTTING MACHINES—See PIPE CUTTING AND THREADING MACHINES.

THROTTLE VALVES—See VALVES.

THRUST BEARINGS.
Bantam Anti-Friction Co., Bantam, Conn.

TILING—See INTERLOCKING RUBBER TILING.

TOILET ACCESSORIES.
Sands, A. B., & Son Co., New York.

TOOLS, MACHINE.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.

TOOLS, MACHINISTS' AND CARPENTERS—See BENCH TOOLS.

TOWING HOOKS AND CHOCKS.
American Engineering Co., Philadelphia, Pa.

TOWING MACHINES.
American Engineering Co., Philadelphia, Pa.

TRANSMISSION ROPE—See ROPE.

TRAPS—See STEAM TRAPS.

TUBES—See BOILER TUBES; also BRASS AND COPPER.

TUBE CLEANERS—See BOILER-FLUE CLEANERS.

TUBE CUTTERS—See BOILER TUBE CUTTERS.

TUGS—See SHIPBUILDERS.

TURBINES—See STEAM TURBINES.

TURNING ENGINES.
American Engineering Co., Philadelphia, Pa.

TURRET LATHES—See LATHES, TURRET.

TWINE—See ROPE—Also CORDAGE.
Columbian Rope Co., Auburn, N. Y.
Plymouth Cordage Co., North Plymouth, Mass.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

TWIST DRILLS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

UNIONS—See PIPE UNIONS.

VACUUM GAUGES—See STEAM GAUGES.

VACUUM TRAPS.
Griscom-Russell Co., New York.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVE RESEATING MACHINES.
Leavitt Machine Co., Orange, Mass.

VALVES—Also see RUBBER VALVES AND WATER VALVES.
American Steam Gauge & Valve Mfg. Co., Boston, Mass.
Ashton Valve Co., Boston, Mass.
Griscom-Russell Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Nelson Valve Co., Philadelphia, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

VALVES—BALANCED THROTTLE VALVES AND QUADRANT VALVES FOR SHIP ENGINES.
Schutte & Körting Co., Philadelphia, Pa.

VALVES, WATER.
Continental Iron Works, Brooklyn, N. Y.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

VARNISH—See PAINT.

VENTILATING FANS—See BLOWERS.

VENTILATORS.
Sands, A. B., & Son Co., New York.

VERTICAL PUMPS—See PUMPS.

VOLTMETERS—See ELECTRICAL INSTRUMENTS.

WATER CLOSETS—PUMP WATER CLOSETS—See PLUMBING.

WATER COLUMNS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Star Brass Mfg. Co., Boston, Mass.

WATER GAUGES AND ALARMS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

WATERPROOF CANVAS—See CANVAS, WATERPROOF.

WATERPROOF LIQUID CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF LIQUID GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

WATERPROOF PAINT.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Ferdinand, L. W., & Co., Boston, Mass.

WATERTUBE BOILERS—See BOILERS.

WATER VALVES—See VALVES, WATER.

WELDING AND WELDING APPARATUS.
Goldschmidt Thermit Co., New York.

WHARF DROPS.
American Engineering Co., Philadelphia, Pa.

WHISTLES.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

WHITE METAL.
Griscom-Russell Co., New York.
Phosphor-Bronze Smelting Co., Philadelphia, Pa.

WINDLASSES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Me.
Lidgerwood Mfg. Co., New York.

WINCHES—See WINDLASSES.

WIRE ROPE
American Engineering Co., Philadelphia, Pa.
Durable Wire Rope Co., Boston, Mass.
Phosphor-Bronze Smelting Co., Ltd., Philadelphia, Pa.
Waterbury Co., New York.

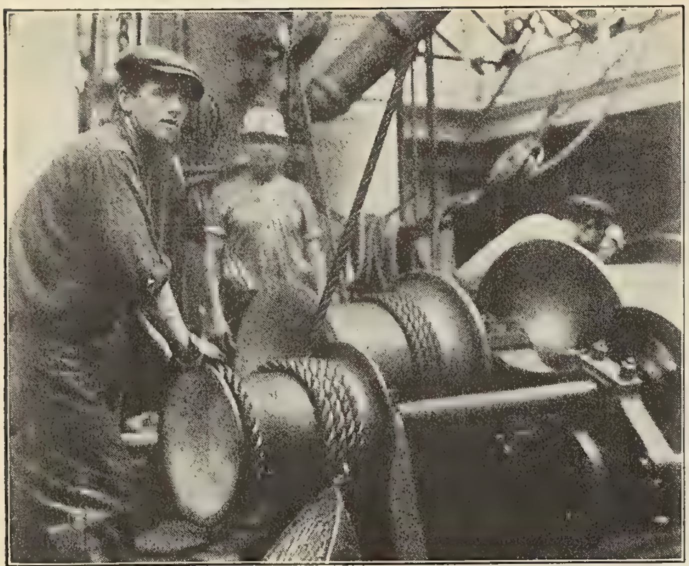
WOOD SAWS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

WRENCHES—Also see PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

YACHT GLUE—See MARINE GLUE.

YACHTS—See LAUNCHES AND YACHTS; also SHIPBUILDERS.

INDEX TO ADVERTISERS

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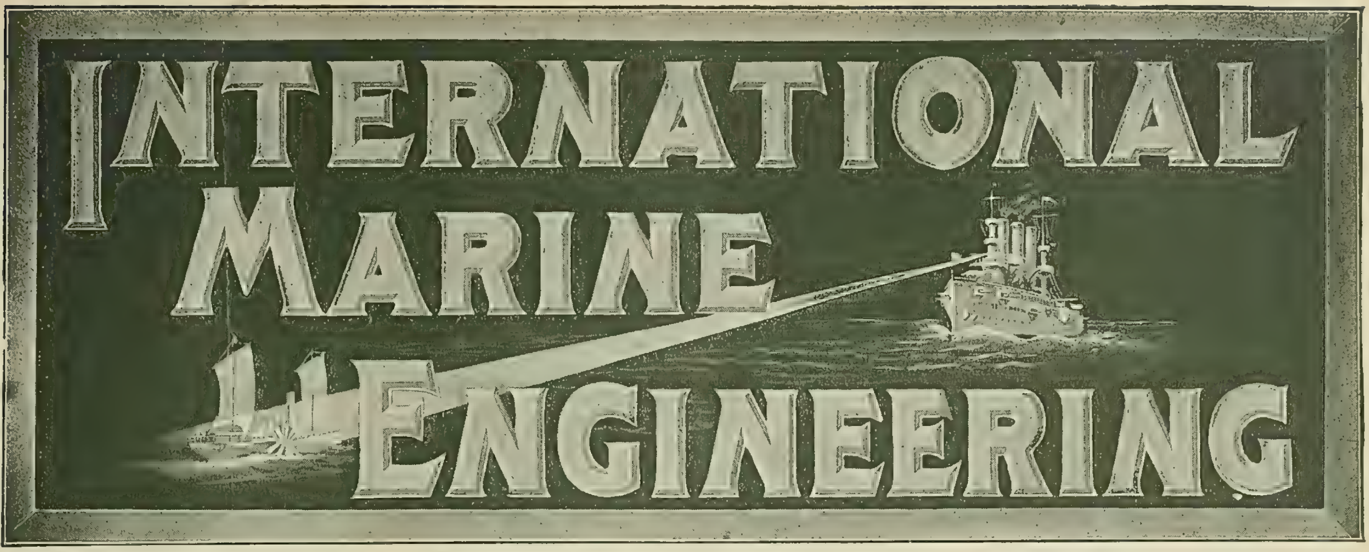
DECEMBER, 1914



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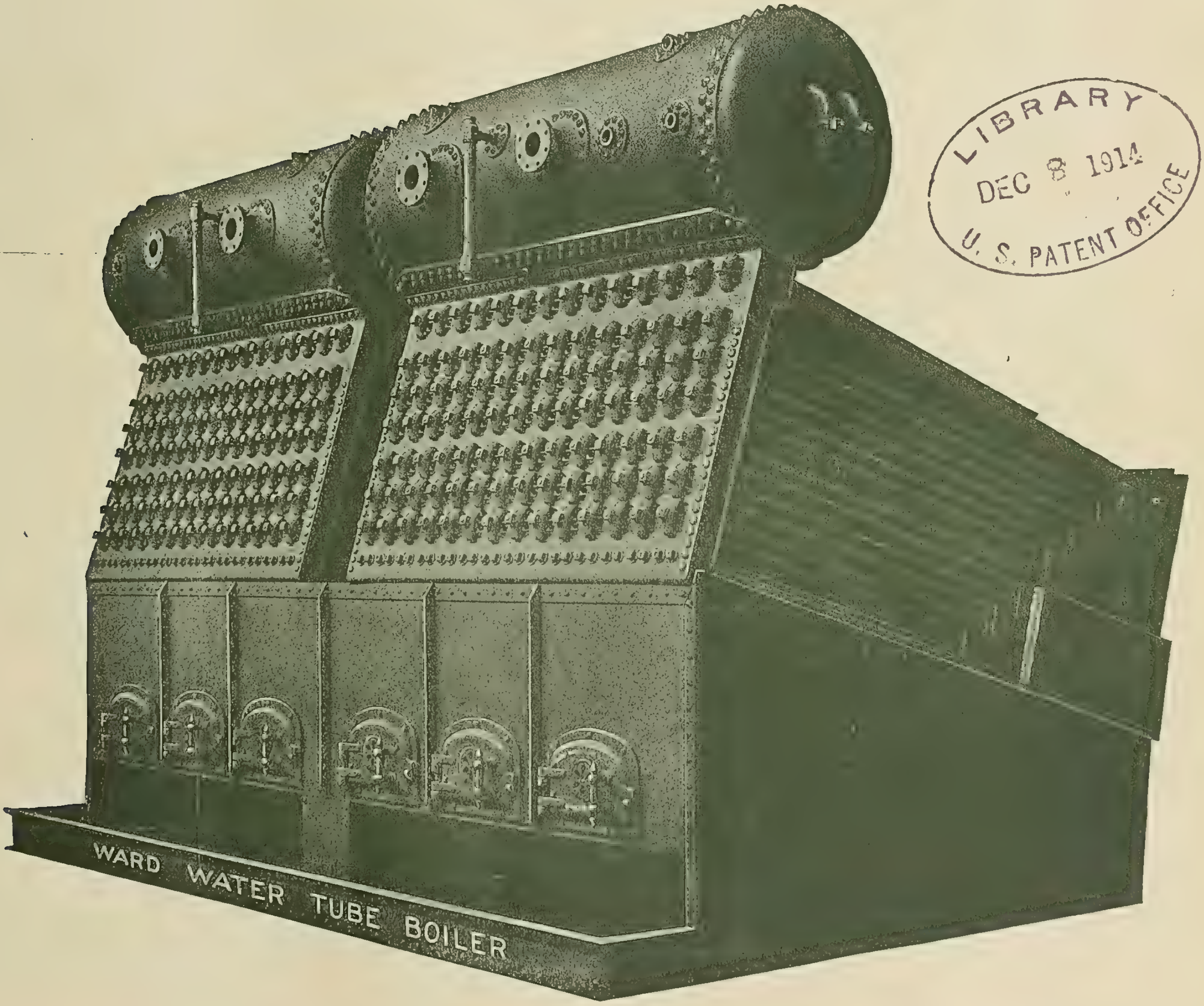
ADOPTED BY UNITED STATES GOVERNMENT



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In successful operation for two seasons on the Missouri River

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GENERATING TUBES EXPANDED. NO OTHER JOINTS

THE CHARLES WARD ENGINEERING WORKS

CHARLESTON, WEST VIRGINIA

International Marine Engineering

DECEMBER, 1914

CONTENTS

LONDON
CHRISTOPHER STREET
FINSBURY SQUARE, E. C.

Branch Office: Boston, 733 Old South Building, S. I. CARPENTER
Entered at New York Post Office as second-class matter.

NEW YORK
WHITEHALL BUILDING
17 BATTERY PLACE

Notice to Advertisers.—Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 20th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 15th of the month.

INTERNATIONAL MARINE ENGINEERING *is one of the original members of the Audit Bureau of Circulations.*

3,900 copies of this issue were printed.

Electric Equipment on Your Boats Will Perform Three Services

Save Lives: The value of the searchlight is well known. It may save more than the entire cost of your electrical equipment in a single hour.

Save Expense: *Electric* lights, *electric* power and *electric* devices are more convenient, more reliable, and hence less expensive than other methods in a long run at sea.

Increase Receipts: Passenger lines increase traffic by adding the searchlight, Edison MAZDA lamps, fans, heaters, etc. The freighter can increase yearly receipts by reducing its time in dock, by motor loading, and by having good light at night with the G-E Searchlight.

The reliability of G-E electrical equipments has long been well known in Marine Service.

Here are some of the G-E Products especially designed for Marine Work

Internal Combustion Generating Sets
Steam Engine Generators
Turbo-Generators
Motors
MAZDA Lamps
Arc Lamps
Searchlights
Incandescent and Arc
Meters and Instruments
Wire and Cable
Wiring Devices
Switchboards
Electric Bake Ovens and Ranges
Electric Radiators
Tubular and Luminous

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For Texas, Oklahoma and Arizona business refer to Southwest General Electric Company (formerly Hobson Electric Co.)—Dallas, El Paso, Houston, and Oklahoma City. For Canadian business refer to Canadian General Electric Company, Ltd., Toronto, Ont. 4836

TRADE PUBLICATIONS.

AMERICA

Small indicating instruments for direct current are described in Bulletin No. 8, a copy of which will be mailed free by the Weston Electrical Instrument Company, Newark, N. J., to any of our readers upon request. This company's portable voltmeters, mili-voltmeters, volt-ammeters, ammeters and mil-ammeters are supplied in single, double and triple ranges. The triple range volt-ammeter comprises six instruments in one. The Weston Electrical Instrument Company has also put on the market a new line of switchboard volt-meters, volt-ammeters, ammeters and mil-ammeters, which it states represent the finest development of small-size pivoted moving coil, permanent magnet type of instruments. The several models and ranges offer a selection from over 300 different combinations, all of which are listed in Bulletin 8.

"Dixon's Silica-Graphite Paint in Brazil" is the title of one of the articles in the October issue of *Graphite,* issued by the Joseph Dixon Crucible Company, Jersey City, N. J. This article is illustrated, and tells about some galvanized iron dock sheds which have been painted with Dixon's silica-graphite. "Para is the chief port of North Brazil and the Amazon, and it gives its name to the vast exportations of Amazon rubber. Into this field the Dixon Company went many years ago, through its London agents, Graphite Products, Ltd. The photograph shows the great port of Para and eight of the galvanized iron dock sheds of the Para Construction Company. The Amazon River Steam Navigation Company were the owners of some galvanized sheds at Para, which were taken over by the Para Construction Company in 1909, and which had been standing for some twenty years before that date and had been protected with Dixon's Silica-Graphite Paint during the whole of that time. Five similar sheds, and two double-deck sheds not shown in this photograph, altogether fifteen cargo sheds of the Para Construction Company at Part, Brazil, are now protected with Dixon's Silica-Graphite Paint. The success of Dixon's Silica-Graphite Paint in tropical and semi-tropical countries, in both the Eastern and Western Hemispheres, has long been established, and this is just one illustration out of the very many of important structures upon which it has rendered the longer and economical service which the Dixon Company advertises. Humidity and heat have no terrors for Dixon's Silica-Graphite Paint."

The K. C. Monteagle patent piston and piston valve packing for all engines, pumps, compressors, etc., is described in a catalogue which has just been published by the Lockwood Manufacturing Company, 61 Sumner street, East Boston, Mass. The Lockwood Manufacturing Company also builds steamships, towboats, marine engines and boilers, and makes a specialty of repairing hulls and machinery.

In Re Male and Female "Kewanee" Unions.—According to a circular published by the National Tube Company, Pittsburg, Pa., "one of the most economical and useful fittings ever placed on the market is the male and female pattern Kewanee union. As its name implies, this union has a male end and a female end combined with the well-known Kewanee advantages. By its use the following saving is effected: One nipple; time required for making one less joint; one gasket; time required for cutting and fitting gasket; cost of one malleable union. Or, in other words, an average net saving of 16 cents. Probably some of your readers are not acquainted with this type of Kewanee union and its merits. At their request we shall deem it a pleasure to forward any of them a copy of the male and female Kewanee union circular."

"Steel Chains" is the title of book No. 124 just issued by the Link-Belt Company, Chicago, Ill. "In manufacturing the steel chains presented herewith, we have made it a point to consider carefully every detail of design, material and construction, with a view to furnishing the best article for the purpose at the lowest practicable price. Without wasting expense on useless outside finish for appearances, we have taken advantage of every facility our experience, modern equipment and skilled workmanship can supply, to furnish a product which will have truer, smoother, harder, and thus more durable, bearing surfaces. By careful specification of the grade of stock purchased for the different parts, we have secured a maximum of strength and durability in the chain as a whole, without material increase in the cost. In the tabulated matter we have endeavored to furnish useful information as to details of size and construction, and where a size of chain is not illustrated in the booklet, we furnish information on separate sheets. In the classification of 'SS' chains we distinguish between offset and straight side bars, and the use or omission of bushings, rollers or pins, as shown in tabulated matter on pages 16 to 25, and illustrations on pages 4 to 11. The chains are listed in the order of their strengths, and for convenience of reference we give a numerical index on page 15."

The installation of "Sirocco" blowers at the Detroit and also at the Canadian plant of the Ford Motor Company is described in an illustrated pamphlet just published by the American Blower Company, Detroit, Mich. This 'Sirocco' installation is the largest of its kind ever made. It is unique in that the only other places where air distribution is handled in a similar manner are at the Ford Canadian plant and a huge machine shop in Baltimore, for which the American Blower Company is now building the heating and air conditioning equipment. This latter contract was placed after an inspection of the Ford plants."

"A Proclamation Prompted by the European War" is the title of a leaflet just published by the Schaeffer & Budenberg Manufacuring Company, Brooklyn, N. Y. In this leaflet the company states that, while its home office is in Germany, the manufacturing organization and facilities of its plant in the United States are complete in every way, as they are also in its English, French, Russian and other European plants. The leaflet accompanies the company's new catalogue, which states: "In this pamphlet we acquaint you with our line of 'instruments for the promotion of efficiency and economy in the power plant and other manufacturing departments of the modern industrial plant.' Every instrument shown is designed and constructed with the aid of an accumulated knowledge gained by over sixty years of study, experimenting and practical experience in solving problems of temperature, pressure, speed, etc. Only the best of materials is ever used. In our plant here in the United States (where all the instruments shown in this pamphlet are built), we maintain a manufacturing organization that is complete in every way. Our men are experts, all thoroughly schooled in the art of instrument making. Our engineering department is perfectly capable, and always willing, to solve any special problem that may confront you. We invite correspondence."

"National" marine and stationary boiler tubes and the many tests to which they are subjected before being placed on the market, are the subject of Bulletin No. 16, published by the National Tube Company, Frick building, Pittsburg, Pa. This bulletin should be in the hands of every one of our readers who is at all interested in the subject, and a copy will be sent free upon request. We quote as follows: "The question of the life of a boiler tube is acknowledged to be of vital importance to every user. The metal used in the manufacture of National boiler tubes is a special grade of weldable boiler tube steel, manufactured by refining the best ore, taken from the Missabe ore ranges in the Superior district. This ore is reduced by an improved plant, which mechanically produces a good, pure, uniform quality of metal without the necessity of dependence upon human labor. By National Tube Company's methods of reduction practically all impurities are removed, so that the metal is nearly pure iron, free from intermixed cinder, the carbon content does not vary more than .01 per cent in a year's work. The metal has sufficient stiffness to hold tight in the flue sheet, and at the same time has abundant ductility. While it is a fact that feed water shows a steadily increasing amount of corrosive matter, yet we are led to the conclusion, through our lengthy and careful experiments, that the deterioration in service is largely due to the inferior quality of the raw material used in the manufacture of the ordinary boiler tube. All National boiler tubes are subjected to rigid inspections and tests. Flattening test—A section three (3) inches long must stand hammering flat, cold, until the inside walls are within three times the thickness of the material without cracking at the bend or elsewhere. In the case of lap-welded tubes for marine work, the bend at one side will be made in the weld. Flanging test—For marine purposes on lap-welded tubes, four (4) inches and smaller, and on all sizes of seamless tubes, a flange three-eighths (3/8) of an inch wide will be turned over at right angles to the body of the tube without showing crack or opening at the weld. Internal-pressure test—Each tube is subjected by the manufacturer to an internal hydrostatic pressure for the respective size and gage, as given in table of dimensions, weights and test pressures. (See National Bulletin No. 16.) Each boiler tube is also given a very careful inspection and examination in order that it shall have a reasonably smooth surface, be free from injurious pits, laminations, cracks, blisters or imperfect welds, bends, buckles, signs of unequal contraction in cooling or injury during manufacture. It is a fact that the steel tube is rapidly replacing other tubes on account of quality, less liability to corrosion and pitting, and much lower price. National Tube Company is satisfied that either National lap-weld spellerized steel boiler tubes, or Shelby seamless steel (cold-drawn or hot-finished) boiler tubes will give, at a decreased cost, better service than the early type of boiler tube."

Condensing equipments for marine service are described in Bulletin 18, issued by the Alberger Pump & Condensing Company, 140 Cedar street, New York. For these outfits the manufacturer claims unusually high efficiency, combined with light weight, making the Alberger spiroflo surface condenser the ideal type for marine service. "The spiroflo construction of this apparatus is the first radical improvement in condenser design since the days of Watt."

"Electric Hoists for the Efficient Handling of All Loads" is the title of a folder just issued by the Sprague Electric Works, 527 West Thirty-fourth street, New York. "Sprague electric hoists are designed to satisfy the demand for efficient lifting and carrying devices to fill the gap between the hand-chain block and the large traveling crane. They range in capacities from $\frac{1}{2}$ to 6 tons. They are built of high-grade material by skilled workmen. They save time and labor. Complete information cheerfully furnished without obligation."

Boiler expanders and other boiler shop tools are described in Catalogue 32, published by the J. Faessler Manufacturing Company, Moberly, Mo. Any Faessler tool will be sent on sixty days' free trial. The company states in reference to the Faessler "Boss" roller expander that besides being the safest and most durable sectional expander made, it is also the quickest. "With it one man can easily do what requires two with an ordinary expander, and, what is more, the one man can do twice as much work as the two can do. In other words, the one man does the work of four, which makes this tool quickly pay for itself."

"Accomplishes More Than Anticipated" is the title of a circular just published by the Hardsocg Wonder Drill Company, Ottumwa, Ia. This circular refers to the "Wonder" riveting machine, and states that about September 1 the company sold one of its 12-foot gap "Wonder" riveting machines to a firm in Racine, Wis., whose name will be given to anyone interested enough to write and ask for it. The letter is as follows: "Replying to your favor of the 19th, in regard to the riveter which you recently furnished us, we will say that we are more than pleased with the work of this riveter. The machine certainly does fine work and accomplishes more than we anticipated that it would."

A valuable rotary shear for use in boiler shops is described in Catalogue 50 just issued by H. Collier Smith, 807 Scotten avenue, Detroit, Mich. This is Mr. Smith's type 4 "Quick-work" rotary shear, which cuts $\frac{3}{8}$-inch thick steel to reverse curve radii of $4\frac{1}{2}$ inches, or a 9-inch diameter hole without cutting in from the side of the sheets. It will cut any lighter gage to proportionately smaller radii; cuts 3-inch radius in 3/16-inch stock in reverse or serpentine curves. The depth of throat of this machine is 30 inches, and it is provided with three changes of speed, instantly controlled by the rear lever. Mr. Smith states that the machine can be started and stopped instantly at any point of the cut by means of a clutch handle.

"Concerning the Removal of Scale in Locomotive Boilers" is the title of one of the articles in the September issue of *Graphite,* and the following statement is made regarding the illustration in connection with this article. Dixon's boiler graphite is also stated to be especially useful on board ship: The above presentation of what happens in the boiler of a locomotive after it has been treated with Dixon's boiler graphite is graphic enough for even the few engineers who still cling to the fashion way of removing scale from boilers. This illustration in connection with the following text is from the *Railway Gazette,* the London edition of the *Railway Age Gazette:* 'Everyone knows that to some extent all undistilled waters used for feeding steam boilers contain impurities, either in suspension or in solution. Everyone knows, too, just what happens when the impurities collect on the boiler shell and tubes in the form of scale or soft mud. In sufficient quantities the deposit will affect the steaming properties or even seriously imperil the safety of the boiler. Graphite of the right kind will prevent the firm adherence of scale on the surfaces of the shell or tubes of a boiler. The action of graphite, such as Dixon's Boiler Graphite No. 2, is not chemical; it does not dissolve the scale nor does it attack the metal, as is often the case with strong compounds; neither is it affected by any acids in the water nor by the heat generated in the boiler. The particles of graphite simply work into the minute cracks existing in the old, hard scale, and gradually penetrate between the scale and the metal. The scale thus loosened may be rapped off or otherwise removed without trouble. A piece of scale so removed from a boiler of an English railway locomotive is illustrated herewith. Further scale cannot adhere firmly to the metal again so long as the graphite treatment is continued, the graphite becoming thoroughly intermixed with new scale as it forms, rendering it soft and crumbly.'"

Economy in purchase of rope is the subject of a circular published by the Whitlock Cordage Company, 46 South street, New York. Any of our readers interested in this subject should send for a copy of the circular.

The Motsinger rotary engine is described in Bulletin 2 just published by the Motsinger Rotary Engine Company, Fredonia, Pa., regarding which the manufacturer makes the following statement: "The single rotary piston engine has from the invention of the first steam engine been the ideal of most inventors and mechanical engineers. The great Watt himself tried hard to make a successful rotary piston engine and failed. Perhaps more money has been spent in research work on this type of engine than on all other types combined. Yet with great respect for the reciprocating engine, which has done so much for humanity, and for the turbine which also promises much, the inventor of our engine, after years of study of known defective conditions, has solved this fascinating problem by the completion of the Fotsinger Double Rotary Engine, which not only eliminates all the bad features of both reciprocating and turbine engines, but retains all their good points. And, like all great scientific discoveries, it is simple in construction, and will prove the longest lived under hard service."

The Prest-O-Lite Welder is described in Book 7 just issued by the Prest-O-Lite Company, Inc., 818 Speedway, Indianapolis, Ind. The manufacturer states that the use of "Presto-O-Lite means a high-pressure installation plant without generators, piping or loss of gas, and that by the use of Prest-O-Lite your entire welding or cutting plant can be quickly and easily moved about and concentrated at the point of use. Using Prest-O-Lite you pay only for the gas you use. You do not pay for wasted gas because none is wasted. In nearly all cases the entire Prest-O-Lite outfit can be operated by one man. The use of Prest-O-Lite makes any good welding and cutting equipment doubly efficient and insures economy, portability, safety, simplicity and ease of operation. It requires no attention—is always ready for instant service." Book 1 contains a fully illustrated description of the Prest-O-Lite welder and a statement of all the claims made by the manufacturer regarding portability, economy, convenience, safety, control and durability. A copy of this booklet will be sent free to any of our readers upon request.

The great size of the business conducted by the B. F. Sturtevant Company, Hyde Park, Boston, Mass., may be realized when it is stated that the company publishes 70 catalogues and bulletins describing its products. These publications have been abridged, and a concentrated description of the Sturtevant products has been published in the new "General Catalogue" just off the press. Any of our readers interested in engines, generating sets, economizers, motors, mechanical draft apparatus, etc., should send for a copy of the general catalogue No. 195-O.

Regrinding valves are described in an illustrated pamphlet just published by the Penberthy Injector Company, Detroit, Mich. "The ever-increasing demand to-day by power plant owners and steam users in general is for valves that will give absolutely reliable service and dependability under high pressures and severe conditions, and that are free from unnecessary renewal of disks and repair parts. To meet this demand the Penberthy regrinding valve has been designed. It is the result of many years of practical experience in the manufacture of high-grade brass goods, and embodies the best mechanical ideas ever employed in mechanical valve construction. The distribution of metal is such that parts subjected to the greatest strain and wear have proportionately heavier walls. For the present we illustrate only the medium pattern type, which is designed to stand a constant working pressure of 200 pounds."

Electric dynamometers are described in Bulletin 48701 published by the Sprague Electric Works, 527 West Thirty-fourth street, New York. "The Sprague electric dynamometer is a machine for measuring horsepower, generated or absorbed. It is a device by means of which actual values of torque and speed can be measured at any and all loads and speeds within the range of the machine under test. It is the ideal device for testing gasoline engines and other prime movers; for testing the power required to drive centrifugal pumps; for testing belts, tires and transmissions. It differs from all other forms of dynamometers in many features which make it pre-eminently suited for the classes of work to which it is applied. Among these features are flexibility, accuracy, simplicity, reliability, economy, the widest range of speeds and the maximum braking effort at all speeds. The Sprague electric dynamometer is built in all sizes from 1 horsepower to 200 horsepower, and for speeds up to 3,500 revolutions per minute."

Walter B. Snow, Publicity Engineer, 136 Federal street, Boston, Mass., has published a folder entitled "How?" which is intended to be the answer to a question so often asked Mr. Snow, "How do you take charge of a client's publicity?" Mr. Snow answers the question in part as follows: "Through a highly specialized organization we are likely to possess, or can readily acquire, an intimate acquaintance with our client's products, their uses and their markets—particularly in the engineering field. Backed by this knowledge we work from the inside, assuming all the duties of an efficient publicity department plus those of an advertising agency—thus duplication of effort is avoided. Regular service is rendered at a salary rate, covering in a single fixed charge all the items of supervision, copy, editorial and clerical work and correspondence. The client contracts through us at net cost with trade papers, printers, engravers, etc. Special work is undertaken on a per diem basis for exact time consumed. National advertising is handled on the usual agency basis. Charges for circularizing are at established rates per thousand."

"Lutz Compression Tools and a Prize Contest in Connection with Them" are the subjects of circulars published by Lutz-Webster Engineering Company, Philadelphia, Pa. This company states: "We have been told that Lutz compression tools fit the needs of almost every condition and requirement of mechanics generally. We want you to prove it. This contest is designed to bring out the best points of merit of Lutz tools from mechanics everywhere, in their regular use, unusual applications and in the origination of new ideas that may be used commercially. To those not having Lutz tools we will grant a special discount of 15 percent from net list prices for this contest only, provided they are ordered in conjunction with the filing of attached registration blank. Tools may be charged to account of responsible concerns, provided formal order is attached to registration card, or will be forwarded through local dealers C. O. D. Usual 30 days' free trial, with return of purchase price, if desired. In addition to cash prizes we will pay for original ideas of value. A chance for a valuable prize—payment for your suggestions and a set of tools at a reduced price."

BUSINESS NOTES

AMERICA

N. L. Stebbins, 132 Boylston street, Boston, Mass., who for many years has made a specialty of marine photographic views, has incorporated his business under the above title, and it will be continued under his personal management. Mr. Stebbins states that he has the most complete collection of negatives of naval vessels, steamships, sailing vessels and yachts in this country. With increased capital and the latest improved instruments, the new corporation is in a position to maintain its established reputation for good work in every line of commercial photography. The corporation has purchased the photographic printing business of Mr. E. V. Gleason, who for twenty years has had charge of that department of Mr. Stebbins' establishment, and this part of the business will be continued under Mr. Gleason's direction.

The Chamberlin Company, Free Press building, Detroit, announces a change of address to 1201, 2 and 3 Kresge building. This company has made a specialty of sales and advertising campaigns for manufacturers of machinery, power plant equipment and other products of a more or less technical nature for a number of years past. Recently, C. W. Brooke, an engineer and long experienced in sales and advertising campaigns in Pittsburg and Buffalo districts, has acquired an interest in the Chamberlin Company, and in keeping with the policy of expansion on the part of the organization, goes to it as their secretary and treasurer. The Chamberlin Company has retained for a period of some nine or ten years a number of the largest and most attractive accounts in the power plant field. In addition to the special fields which heretofore have required exclusive attention, the new organization will make a feature of handling sales and advertising campaigns for manufacturers in the electrical world as well as the preparation of technical matter on a special assignment basis for advertisers in general. William M. Chamberlin, the head of the company, has had a wide experience along the line of art, printing and general advertising, having been engaged exclusively in the technical field for the past ten years.

THE EXPERIENCE OF A MARINE ENGINEER with an A. B. C vertical engine. The American Blower Company, Detroit, Mich., has received the following letter from E. H. Parry, chief engineer, steamer *James Corrigan*, Marine Postoffice, Detroit, Mich. Mr. Parry adds as a postscript to his letter that the old casting he mentions was broken by falling and not through wear: "Will you kindly ship me a finished casting marked A. 648 for blower engine No. 4400, type A, size 7 by 7, to steamer *James Corrigan?* We have three of your engines in use on the *Corrigan* that have been in constant use through the season of navigation since the spring of 1908, and this will be the first expenditure for repairs in that time. Two of the engines are connected to dynamos and one to the fan that furnishes air for draft system to boilers. If you will ship this casting by parcels post it will be delivered to us as we pass Detroit by the United States mail boat."

RECENT ORDERS RECEIVED by The McNab Company, Bridgeport, Conn. The McNab Company writes to INTERNATIONAL MARINE ENGINEERING that it has received, recently, the following orders: Two Willett-Bruce automatic steamship whistle controls for steamship *Great Northern* and steamship McNab direction indicators for Pacific mail steamers *Persia, Nile, San Jose, Peru, City of Para, Pennsylvania, City of Sydney, Aztec, San Juan*, etc. This repeat order now completes the fleet installation with this instrument. The Southern Pacific Company has sent in a repeat order and been supplied with seven McNab direction indicators for their steamers. McNab direction indicators are installed and being installed on the new steamships *John D. Rockefeller* and *John D. Archbold*, the latter vessel completing at the Newport News Shipbuilding & Dry Dock Company for the Standard Oil Company of New Jersey. Three McNab direction and revolution indicators, one McNab pneumatic counter, and one Willett-Bruce automatic steamship whistle control have been ordered for new steamship *J. A. Moffett*, completing at the Union Iron Works Co., San Francisco, for the Standard Oil Company of California. Thirty-two furnaces in boilers of the steamships *Mexican* and *Columbian* have recently been installed with McNab "Cascade" circulators and fuel economizers, and one Willett-Bruce automatic steamship whistle control has been installed on steamship *Columbian* of the American-Hawaiian Steamship Company of New York.

PROBABLY THE GREATEST RECORD of hoisting engine production made by any one concern is that of the Lidgerwood Manufacturing Company, 96 Liberty street, New York, which has built more than 37,000 steam and electric hoists during the forty odd years that it has been in business. A comparison of the types of machines built to-day with those of thirty years ago still in operation is very interesting from an engineering standpoint, as showing the improvements and advancement that have been made in hoisting machinery practice.

IN REFERENCE TO FUSIBLE PLUGS.—During September, 1914, the following companies submitted affidavits to the Steamboat Inspection Service at Washington, D. C., in regard to the manufacture of fusible plugs, as required by the bureau's circular letter dated June 30, 1914: Sucesores De Abarca, San Juan, P. R.; Manistee Iron Works, Manistee, Mich.; Crane Company, Bridgeport, Conn.; Union Iron Works Company, San Francisco, Cal.; Vulcan Iron Works, Cairo, Ill.; The Campbell's Creek Coal Company, Dana, W. Va.; Wiggings Ferry Company, St. Louis, Mo.; Sherwood Manufacturing Company, Buffalo, N. Y.; Elisha Webb & Son Company, Philadelphia, Pa.; Milwaukee Dry Dock Company, Milwaukee, Wis.; C. H. McCutcheon, Buffalo, N. Y.; L. Katzenstein & Company, New York; The Chaplin-Fulton Manufacturing Company, Pittsburg, Pa.; The McKinnon Iron Works Company, Ashtabula, Ohio; Richards Iron Works, Manitowoc, Wis.; Dunham Towing & Wrecking Company, Chicago, Ill.; Fries & Company, Buffalo, N. Y.; John Baizley Iron Works, Philadelphia, Pa.; W. S. Cahill Company, Baltimore, Md.; Kelly & Jones Company, Greensburg, Pa.; General Fire Extinguisher Company, Providence, R. I.; American Injector Company, Detroit, Mich.

DURING THE MONTH OF OCTOBER the following-named companies submitted affidavits in regard to the manufacture of fusible plugs as required by the Bureau of Steamboat Inspection Service's circular letter, dated June 30, 1914: Moran Flexible Steam Joint Company, Louisville, Ky.; Deck Bros., Buffalo, N. Y.; Thomas B. Banner, Chicago, Ill.; The Skinner & Arnold Company, Albany, N. Y.; B. Hoffmann Manufacturing Company, Milwaukee, Wis.; Southern Brass Manufacturing & Plating Company, Houston, Tex.; Gillett, Eaton & Squire, Lake City, Minn.; A. Nicholson, Albany, N. Y.

The Gisholt Machine Company, of Warren, Pa., and Madison, Wis., states that it is prepared to do outside work, and that it will build your machinery, complete or individual parts, whether it is standard or special machinery. The company's plants are stated to be modern and fireproof, including foundry, pattern shop, pattern storage and machine shop, and to be equipped with the latest and most approved appliances in every department.

Orders for Eckliff Circulators.—The Eckliff Automatic Boiler Circulator Company, 46 Shelby street, Detroit, Mich., writes International Marine Engineering that among recent orders for its circulators are the following: Coastwise Transportation Company's steamship *Middlesex,* St. Joseph-Chicago Steamship Company's steamship *Eastland,* four tugs for the Isthmian Canal Commission, United States auxiliary cruiser *Dixie,* United States army engineer dredge *Burton,* United States army engineers' tug *Spear,* and three plants for the Great Lakes Dredge & Dock Company.

The Abbott Ball Company, Hartford, Conn., states that it has installed special machinery whereby it is able to turn out all sizes of balls from 1/8 inch to 1/2 inch in diameter, and that it will soon be in a position to furnish all other sizes.

TRADE PUBLICATIONS

GREAT BRITAIN

The Isherwood System of ship construction is described and illustrated in a booklet just published by J. W. Isherwood, 4 Lloyds avenue, London, E. C. The introduction is as follows: "Now that there are 297 vessels, aggregating 1,380,918 gross register tons, built or under construction, and shipbuilders already operating the system, the Isherwood System is so firmly established that it should hardly be necessary to explain that this is a compound system, consisting of heavy transverse frames, widely spaced (say 12 feet apart), such frames being slotted to allow longitudinal frames to be passed through them on the whole skin of the ship; that is to say, these fore and aft frames are fitted at close-spaced intervals under the deck and along the sides and along the bottom of the vessel, with intermediate transverse frames in the double bottom to withstand grounding. The transverse and longitudinal frames are joined together by lugs, thus forming a homogeneous framework complete without the shell plating, but which framework, together with the shell plating, provides a girder absolutely unique so far as ship construction is concerned. The extra strength in the case of a vessel of normal dimensions amounts to about 20 percent in the longitudinal direction, and to something like 5 percent to 10 percent in the transverse direction, whilst there is no doubt that this compound system resists torsional stresses in a manner which has never been provided for in the case of vessels built on the old system. It is well at this point to refer to the fact that a practice has been introduced recently of leaving out stringers in the case of vessels built on the old-fashioned system. This has further tended to reduce the resistance of vessels built on the old system to torsional stresses, besides which there is more liability of the vertical frames showing signs of tripping where there is no support from stringers. Whilst discussing this absolutely invaluable feature of added strength,

IMPORTANT ARTICLES
PUBLISHED IN
INTERNATIONAL MARINE ENGINEERING

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29 West 39th Street, New York City.

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Bolbec Hall, Westgate Road, Newcastle-on-Tyne.

INSTITUTE OF MARINE ENGINEERS, INCORP.
58 Romford Road, Stratford, London, E.

---

it may be pointed out vessels of various designs where radical departures have been made in the method of distribution of material developed serious defects and have shown structural weakness. Now, those who have traced the career of all the Isherwood ships afloat are in a position to state authoritatively that there has been no case of any serious damage through simple stress of weather in the case of a ship built on the Isherwood System, and, moreover, it is a fact that several of these vessels have been badly aground and come off again with little or no damage, and underwriters will probably find that there will be few, if any, total losses from stranding, because the bottom plating is so much better supported, and the deck is so strong longitudinally that it is very improbable that any ship built on the Isherwood system will break her back."

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—to get rid of the delay, muss, expense and inefficiency of icing;

—to carry ships' stores and perishable cargo of any kind for an indefinite period without loss;

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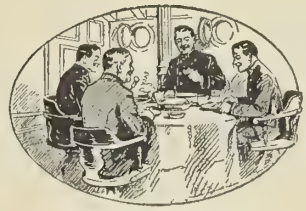

BRUNSWICK

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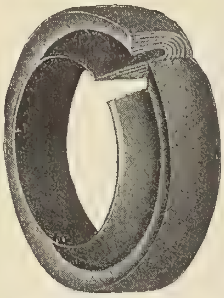
At Least 5% of Your Power Is Wasted by Rod Friction



It is estimated that rod friction, caused by soft packing, consumes at least 5% of an engine's power.

Rather interesting, when you consider that this means a waste of 5% of the coal which creates the power.

With soft packing it is necessary to screw the gland tight—in order to prevent leakage of steam. Thus the friction is constant—always acting on the piston like a brake.

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Eliminate 75% of This Friction

This means fuel bills are cut approximately 4%.

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Steam enters the hollow space between the "lip" and the "heel," forcing the "lip" against the rod with just enough pressure to prevent leakage.

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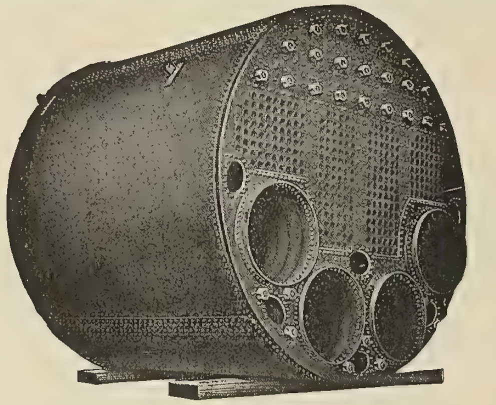

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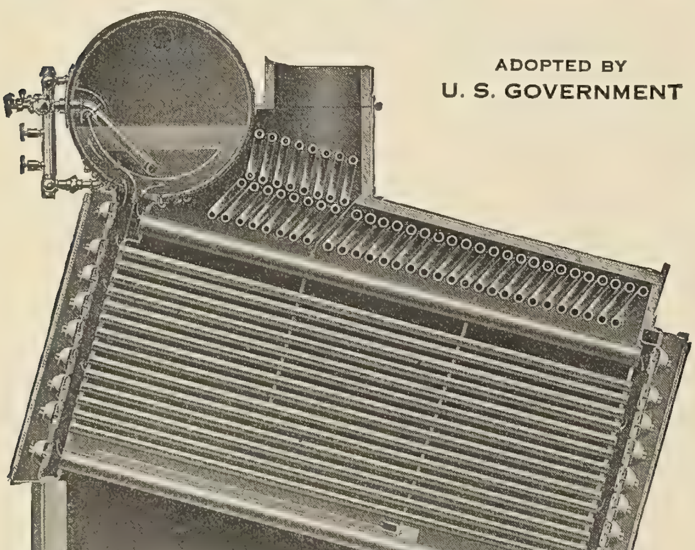

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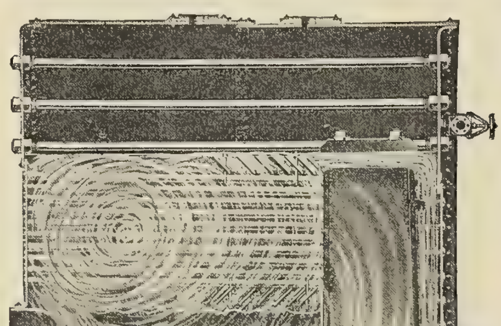

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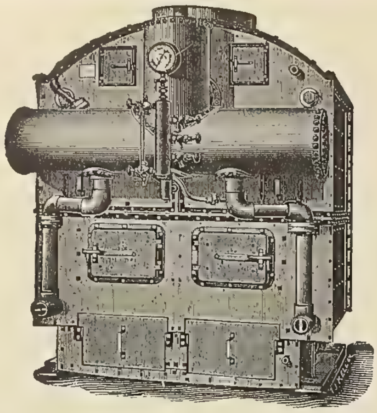

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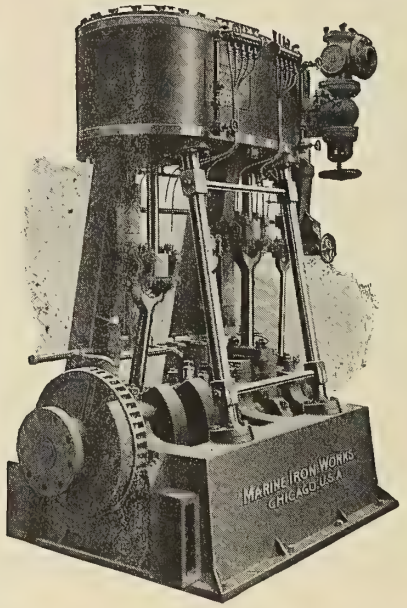

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Also complete line of Steamboat Machinery

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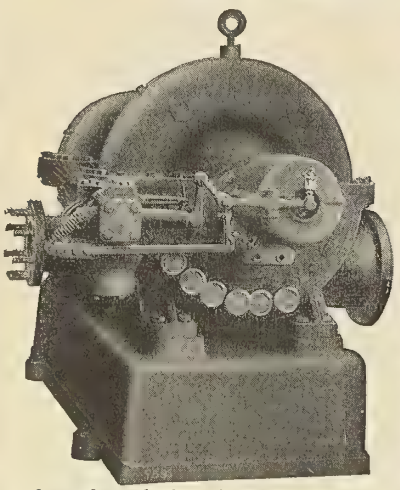

Because the nozzles are carefully reamed to the correct shape for the given steam conditions. The buckets are drop-forged from nickel bronze and retain the original glossy surface imparted by the drop-forging process. The guide vanes, of the same type and material, return the steam upon the succeeding rows of moving blades with the least loss by shock or friction. Another feature conducive to high efficiency is the provision of shut-off valves for closing individual nozzles when they are not required for carrying the load.

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Is a reduction in your coal bill of any interest to you?

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We are constantly receiving "repeat orders" from owners of merchant vessels who have had many years' satisfaction from the earlier installations.

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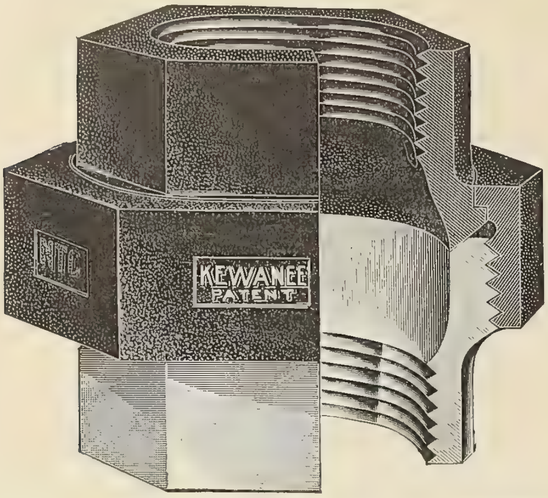

The Air-Tested Union With No Inserted Parts
The "Safety-First" Union

Something To Look At.

It was something to look at—a union that would not leak. No wonder a crowd gathered round it. That was 8 years ago. Now leaklessness is common in that plant—"KEWANEE" has made it so. The following letter from one of the jobbing concerns* in the Texas Oil District tells the story:

"Gentlemen:—About eight years ago, when I was store keeper for one of the large Refineries here, a small 'KEWANEE' Union was sent as a sample with an order of fittings. It was immediately put on a steam line and tried out, a crowd gathered about to see it, and seeing that it worked so perfectly, a small stock was ordered and placed for 'KEWANEE' Unions.

"There had been a great deal of trouble with leaking joints, and within one year nearly every Union in the plant had been replaced with a 'KEWANEE.'

"The pay-roll runs about $20,000.00 per month and the next year the difference in labor and material was very noticeable.

"Very respectfully,

"Mgr. MILL SUPPLY DEPARTMENT."

Remember those Five "KEWANEE" Reasons

(1) Brass to iron thread connection—No corrosion.
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(3) 125 pounds Compressed air test under water—No defective fittings.
(4) Solid three-piece construction—No inserted parts.
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Learn all about "KEWANEE." Write for **The Whole "KEWANEE" Family.**

* Name and address supplied if you want them.

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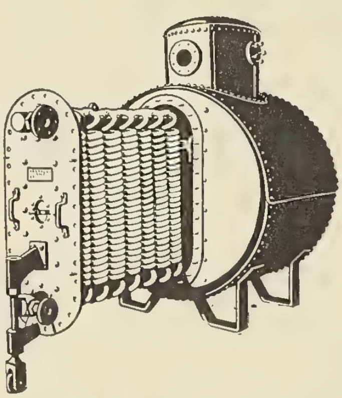
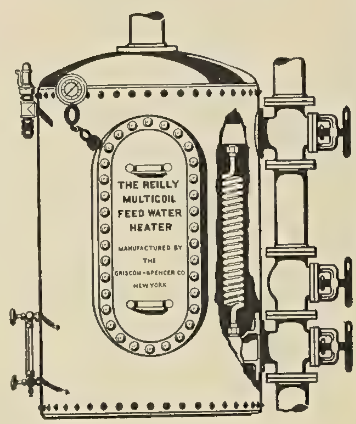


Already have millions of horse-power to their credit in the marine field, and the total rises each month. Specially designed to meet the severe requirements on board ship, they

Save Space and Fuel

by the use of copper coils wound to a small radius and presenting large heating surface in compact form. All coils made to a standard and interchangeable — readily accessible through a large door in the shell. Coil ends equipped with copper faced, flanged, quick-detachable joints, free from brazing. A few spare coils mean peace of mind.



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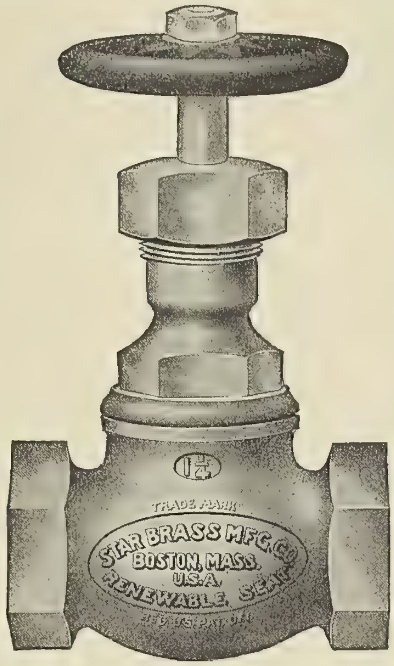

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All castings of our special bronze mixture, made from metal patterns on pneumatic molding machines.

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Body of special rugged design; steam is not retarded in its flow owing to body's form—it is so designed that metal is distributed where most needed for severe use.

Seat and Disc are both Renewable and extra heavy; the bevel or taper of both is at a sharp angle, with a very light bearing, insuring less liability of foreign matter lodging on seat when valve is closed, also less chance of wire drawing and cutting.

Seat rings are of a "Patented" form with special taper seat where screwed in body. This design insures a perfect joint and absence of liability to distortion from lack of care in installation or unequal expansion in use.

The bonnet is novel in design, having many unique features. First, it is absolutely self-draining, thereby eliminating all liability to freeze when used in cold positions; has extra large and deep packing space, gland and nut. Long thread in body, insuring strength and tightness.

Stems or spindles are extra heavy, made with large "Acme" quick-opening threads.

Valves can be re-packed under pressure, when wide open, as top of discs seat against bottom of bonnet, making steam-tight joint.

Handwheel is fastened to stem with hexagon nut, and can readily be removed and replaced.

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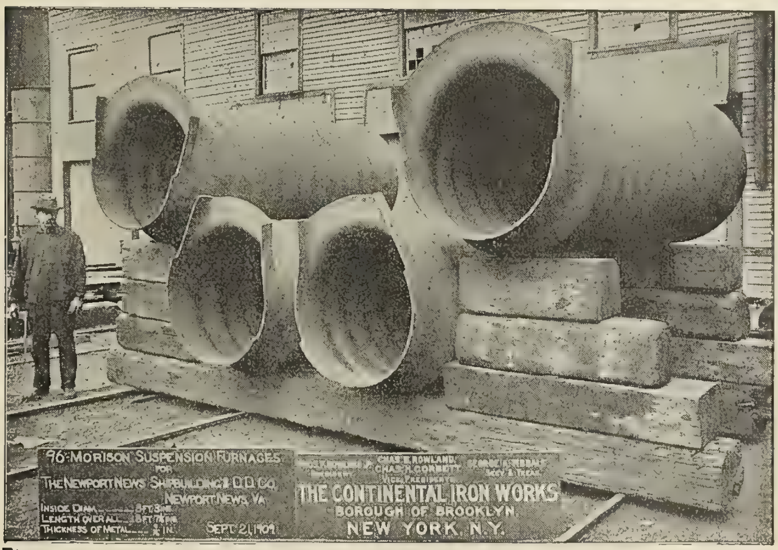

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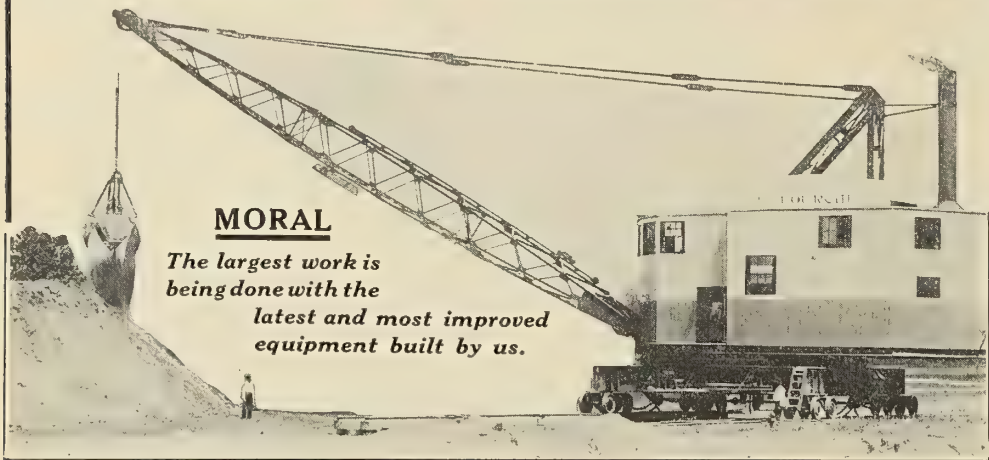

The crane shown in the illustration is owned and operated by the Lafourche Basin Levee Board. It is fitted with an 88 foot boom and 2 1-2 yard Hayward Orange Peel Bucket.

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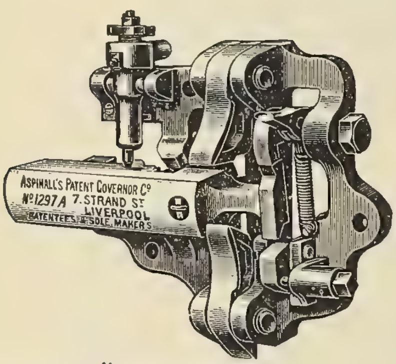

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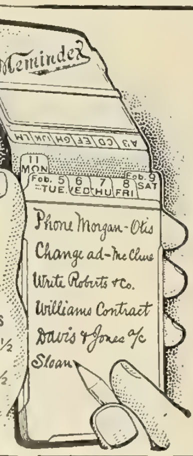

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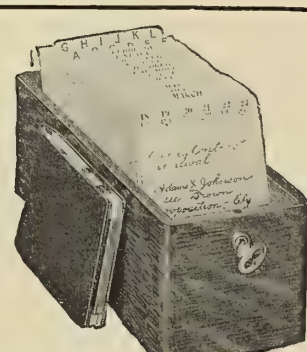

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Ship from 22 Mines in the Pocahontas Field — Ship 4,000,000 tons per annum by all-rail, tidewater and the Great Lakes

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Fixed Carbon	74.81	per cent
Volatile Matter	18.88	"
Sulphur	.67	"
Ash	4.79	"
Moisture	.85	"
Total	100.00	"
British Thermal Units	15003	

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This coal is marketed under the brand of "Original Pocahontas." The first shipments of coal from the Pocahontas Field were made from the mines of the Pocahontas Consolidated Collieries Company, Incorporated, at Pocahontas, Virginia, in 1882, which mines have since continuously mined and are now mining the No. 3 vein and are shipping the highest grade of Pocahontas coal.

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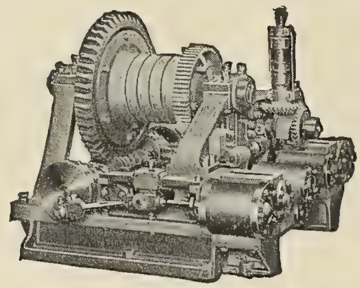

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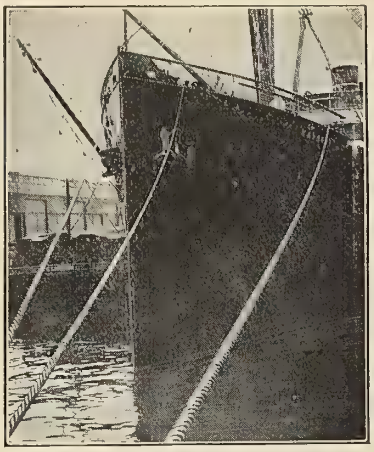

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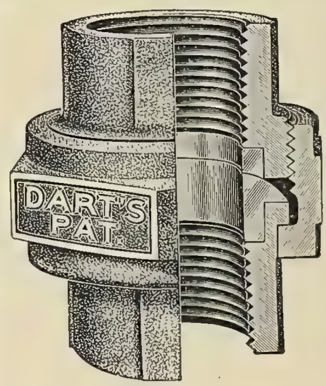

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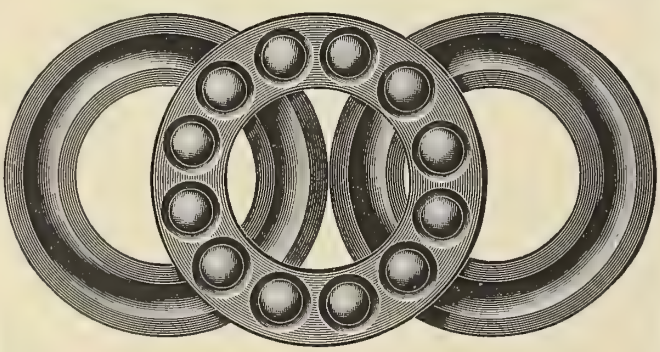

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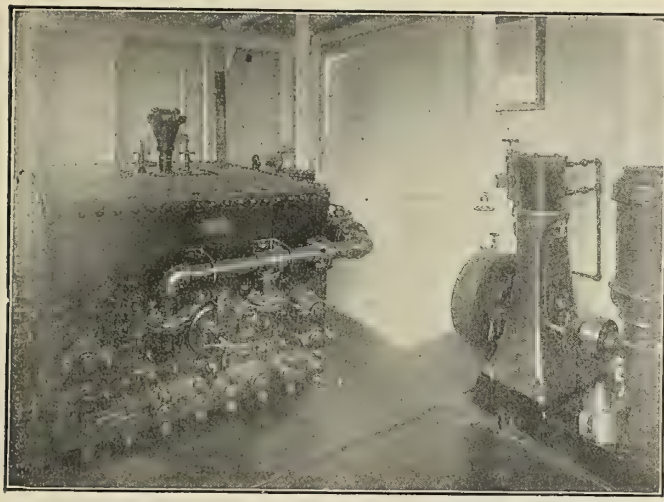

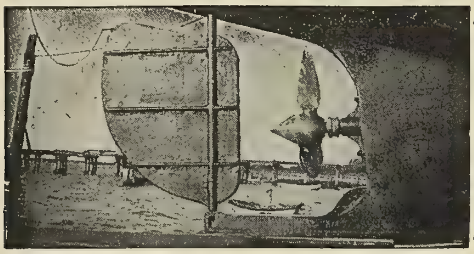

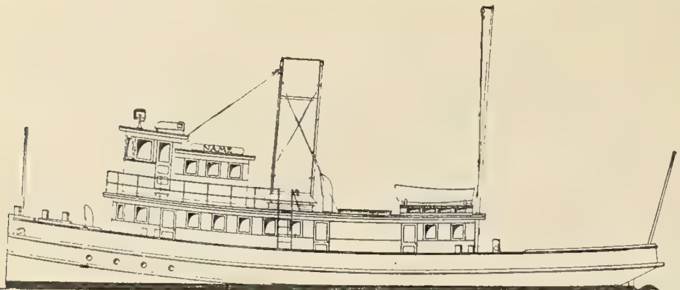

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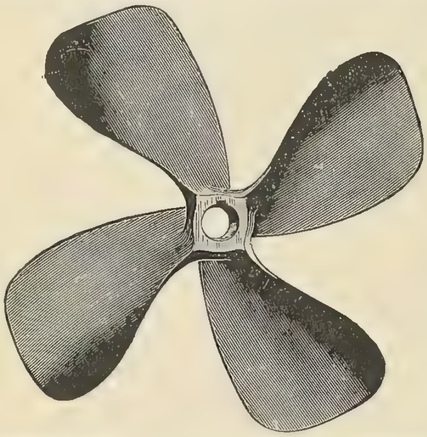

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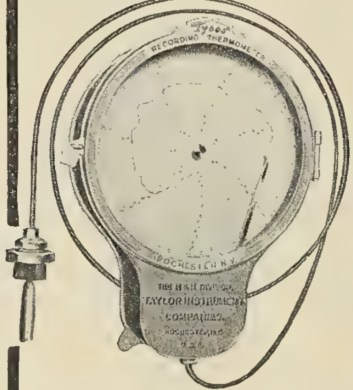

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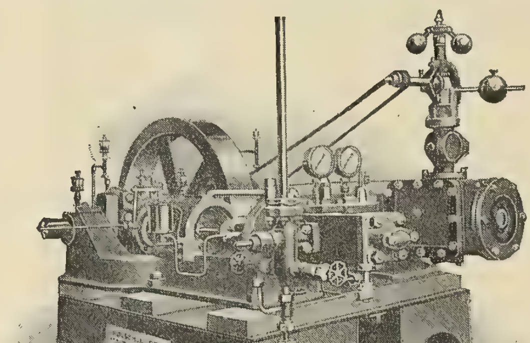

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DRYING APPARATUS.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

DYNAMOS—SEE ELECTRIC PLANTS; ALSO STEAM TURBINE DYNAMOS.

ECONOMIZERS, FUEL—SEE FUEL ECONOMIZERS.

EJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ELECTRIC DRILLS.
General Electric Co., Schenectady, N. Y.
Independent Pneumatic Tool Co., Chicago and New York.

ELECTRIC FREIGHT TRUCKS—See FREIGHT-HANDLING EQUIPMENT

ELECTRIC HEATERS.
General Electric Co., Schenectady, N. Y.
Johns-Manville Co., H. W., New York.
Simplex Electric Heating Co., Cambridgeport, Mass.

ELECTRIC HOISTS.
American Engineering Co., Philadelphia, Pa.
Brown Hoisting Machinery Co., Cleveland, Ohio.
General Electric Co., Schenectady, N. Y.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.
Niles-Bement-Pond Co., New York.

ELECTRIC LIGHTS.
General Electric Co., Schenectady, N. Y.
Johns-Manville Co., H. W., New York.

ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Machine Co., East Pittsburgh, Pa.

ELECTRICAL FITTINGS AND SUPPLIES—ALSO SEE ELECTRIC PLANTS.
General Electric Co., Schenectady, N. Y.
Griscom-Russell Co., New York.
Johns-Manville Co., H. W., New York.

ELECTRICAL INSTRUMENTS.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

ELEVATORS, FREIGHT—See FREIGHT ELEVATORS, also INCLINED ELEVATORS.

ENGINE PACKING—See PACKING.

ENGINE-ROOM SUPPLIES—See STEAM SPECIALTIES.

ENGINEERS, CONSULTING AND CONTRACTORS.
American Engineering Co., Philadelphia, Pa.
Donnelly, W. T., New York.
Griscom-Russell Co., New York.
Hough, Edward S., San Francisco, Cal.
Watts, J. Murray, Philadelphia, Pa.

ENGINES FOR AUXILIARIES.
Alberger Pump and Condenser Co., New York.
American Blower Co., Detroit, Mich.
American Engineering Co., Philadelphia, Pa.
De Laval Steam Turbine Co., Trenton, N. J.
Hyde Windlass Co., Bath, Maine.
Marine Iron Works, Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.
Westinghouse Machine Co., East Pittsburgh, Pa.

ENGINES, GASOLINE—See GASOLINE ENGINES.

ENGINES, HOISTING—See HOISTING ENGINES.

ENGINES, KEROSENE—See KEROSENE ENGINES.

ENGINES, OIL.
Standard Motor Construction Co., Jersey City, N. J.

ENGINES—PROPELLING.
Bath Iron Works, Bath, Maine.
Galusha & Co., A. L., Boston, Mass.
Kingsford Foundry & Machine Works, Oswego N. Y.
Marine Iron Works, Chicago, Ill.
Parsons Marine Steam Turbine Co., New York.
Sheriffs Mfg. Co., Milwaukee, Wis.
Standard Motor Construction Co., Jersey City, N. J.
Trout, H. G., Co., Buffalo, N. Y.
Ward, Chas., Engineering Works, Charleston, W. Va

ENGINES—PUMPING.
Alberger Pump and Condenser Co., New York.
Davidson, M. T., Co., New York.
Griscom-Russell Co., New York.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Terry Steam Turbine Co., Hartford, Conn.

ENGINE-ROOM CLOCKS—See CLOCKS.

ESCALATORS.
Otis Elevator Co., New York.

EVAPORATORS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Davidson, M. T., Co., New York.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

EXCESS PUMP GOVERNORS—See PUMP GOVERNORS.

EXHAUST FANS—See BLOWERS.

EXHAUST HEADS.
Sturtevant Co., B. F., Hyde Park, Mass.

EXPANDERS—See BOILER FLUE AND TUBE EXPANDERS.

EXPANSION JOINTS.
Alberger Pump and Condenser Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.

FANS—See BLOWERS.

FEED CHECK VALVES—See VALVES.

FEED-WATER HEATERS AND PURIFIERS.
Alberger Pump and Condenser Co., New York.
American Engineering Co., Philadelphia, Pa.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FEED-WATER REGULATORS.
Alberger Pump and Condenser Co., New York.
Jerguson Gage & Valve Co., Boston, Mass.

FERRY BOAT LAMPS—See LAMPS.

FILES.
Nicholson File Co., Providence, R. I.

FILTERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

FIRE DEPARTMENT SUPPLIES.
Aero Fire Alarm Co., New York.
Fumigating & Fire Extinguishing Co. of America, New York
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE EXTINGUISHERS.
Aero Fire Alarm Co., New York.
Fumigating & Fire Extinguishing Co. of America, New York
Johns-Manville Co., H. W., New York.
Morse, Andrew J., & Son, Inc., Boston, Mass.

FIRE HOSE—See HOSE.

FIREPROOF CONSTRUCTION.
Johns-Manville, H. W., Co., New York.
Keyes Products Co., New York.

FIREPROOF LUMBER—See LUMBER, FIREPROOF.

FIRE PUMPS—See PUMPS.

FLANGES.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

FLANGING PRESSES.
Niles-Bement-Pond Co., New York.

FLOATING DRY DOCKS—See DRY DOCKS.

FLUE CLEANERS—See BOILER FLUE CLEANERS.

FLUE CUTTERS—See BOILER FLUE AND TUBE CUTTERS.

FORCED DRAFT—See also BLOWERS.
American Blower Co., Detroit, Mich.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., East Pittsburgh, Pa.

FORGES.
Sturtevant Co., B. F., Hyde Park, Mass.

FORGINGS, BRONZE—See also DROP FORGINGS.
Hyde Windlass Co., Bath, Me.

FREIGHT ELEVATORS FOR DOCKS AND WHARVES
Otis Elevator Co., New York.

FREIGHT-HANDLING EQUIPMENT.
Brown Hoisting Machinery Co., Cleveland, Ohio.
Elwell-Parker Electric Co, New York.
Link-Belt Co., Chicago, Ill.
McMyler-Interstate Co., The, Cleveland, Ohio.
Otis Elevator Co., New York.

FRIGIDOMETERS.
McNab Co., The, Bridgeport, Conn.

FROSTPROOF COVERINGS.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

FUEL ECONOMIZERS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

FUEL OIL BURNERS.
Schutte & Körting Co., Philadelphia, Pa.

FURNACE FRONTS—MARINE AND STATIONARY.
Continental Iron Works, The, Brooklyn, N. Y.

FURNACES—Also see CORRUGATED FURNACES.
Continental Iron Works, The, Brooklyn, N. Y.

FURNACE BRIDGE WALLS
Wager, Robert H., New York.

FUSIBLE PLUGS.
Griscom-Russell Co., New York.
Johns-Manville Co., H. W., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

GALLEYS—See RANGES.

GAS BLOWERS AND EXHAUSTERS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

GASKETS—Also see PACKING.
Griscom-Russell Co., New York.
Johns-Manville, H. W., Co., New York.
New York Belting & Packing Co., New York.
Peerless Rubber Mfg. Co., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

GASOLINE ENGINES—Also see LAUNCHES AND YACHTS. KEROSENE ENGINES; OIL ENGINES.
Bridgeport Motor Co., Bridgeport, Conn.
Standard Motor Construction Co., Jersey City, N. J.

GAS ENGINE SPECIALTIES.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburgh, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

GAS PRODUCERS—See MARINE GAS PRODUCERS.

GATE VALVES—See VALVES.

GAUGE COCKS.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.
Williams Valve Co., D. T., Cincinnati, Ohio.

GAUGES—See STEAM GAUGES; also WATER GAUGES.

GAUGE GLASSES.
Jerguson Gage & Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

GENERATORS—See ELECTRIC PLANTS.

GLOBE VALVES—See VALVES.

GLUE—LINOLEUM, MARINE, SHIP, YACHT, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

GOVERNORS—See PUMP GOVERNORS.

GRABS—See DREDGING MACHINES.

GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

GRATE BARS.
Griscom-Russell Co., New York.

GREASE—See LUBRICANTS.

GREASE CUPS—See LUBRICATORS.
Albany Lubricating Co., New York.
Griscom-Russell Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

GREASE EXTRACTORS.
Griscom-Russell Co., New York.

GYPSEYS.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

HAMMERS, PNEUMATIC—See PNEUMATIC TOOLS.

HARDWARE—See MARINE HARDWARE; also CHANDLERY STORES.

HARDWOOD—See LUMBER.

HAWSERS—See WIRE ROPE.

HEATERS—BATH, LAVATORY, SHOWER.
Alberger Pump and Condenser Co., New York.
Sands, A. B., & Son Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

HEATING AND VENTILATING APPARATUS.
American Blower Co., Detroit, Mich.
Schutte & Körting Co., Philadelphia, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

HEMP—See TWINE.

HOISTING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.
Lidgerwood Mfg. Co., New York.

HOISTS, CHAIN—See CHAIN HOISTS.

HOISTS, ELECTRIC—See ELECTRIC HOISTS.

HOSE—See AIR HOSE.
Eureka Fire Hose Mfg. Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
Johns-Manville Co., H. W., New York.
New York Belting & Packing Co., New York.

HOSE COUPLING.
Eureka Fire Hose Mfg. Co., New York.
Independent Pneumatic Tool Co., Chicago and New York.
National Tube Co., Pittsburg, Pa.

HOSE NOZZLES.
Morse, Andrew J., Son, Inc., Boston, Mass.

HUMIDIFIERS.
Griscom-Russell Co., New York.

HYDRAULIC FITTINGS.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

HYDRAULIC MACHINERY—RIVETERS, PUNCHES, SHEARS.
Niles-Bement-Pond Co., New York.

ICE DETECTORS.
McNab Co., The, Bridgeport, Conn.

ICE MACHINES—See REFRIGERATING PLANTS.

INCLINED ELEVATORS FOR DOCKS AND WHARVES.
Otis Elevator Co., New York.

INDICATOR CONNECTIONS.
Lunkenheimer Co., Cincinnati, Ohio.

INDICATORS—STEAM AND GAS ENGINE—Also see DIRECTION AND REVOLUTION INDICATORS.—Also RUDDER POSITION INDICATORS.
Johns-Manville Co., H. W., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

INDUCED DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

INJECTORS.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

INSURANCE—MARINE AND FIRE.
Hutchinson, Rivinus & Co., New York and Philadelphia.

INTERLOCKING RUBBER TILING.
Griscom-Russell Co., New York.
New York Belting & Packing Co., New York.

IRON CEMENT.
Johns-Manville Co., H. W., New York.
Smooth-On Mfg. Co., Jersey City, N. J.

JACKS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York

JOURNAL BEARINGS—See THRUST BEARINGS.

JUTE.
Columbian Rope Co., Auburn and New York.

KEROSENE ENGINES—See also OIL ENGINES AND DIESEL ENGINES.
Standard Motor Construction Co., Jersey City, N. J.

LATHES, CRANK SHAFT.
Niles-Bement-Pond Co., New York.

LAMPS, SIGNALS, AND FIXTURES.
General Electric Co., Schenectady, N. Y.
Johns-Manville, H. W., Co., New York.

LATHES, ENGINE.
Niles-Bement-Pond Co., New York.

LATHES, TURRET.
Niles-Bement-Pond Co., New York.

LAUNCHES AND YACHTS—See also SHIPBUILDERS AND DRY DOCK COMPANIES—Also PROFESSIONAL CARDS.
Bridgeport Motor Co., Bridgeport, Conn.
Marine Iron Works, Chicago, Ill.
Standard Motor Construction Co., Jersey City, N. J.
Ward, Chas., Engineering Works, Charleston, W. Va.
Welin Marine Equipment Co., Long Island City, N. Y.

LAVATORIES—FOLDING, STATIONARY, STATEROOM.
Sands, A. B., & Son Co., New York.

LAVATORY AND BATH HEATERS.
Griscom-Russell Co., New York.
Schutte & Körting Co., Philadelphia, Pa.

LIFE BOATS AND RAFTS.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE PRESERVERS.
Ferdinand, L. W., & Co., Boston, Mass.
Welin Marine Equipment Co., Long Island City, N. Y.

LIFE-SAVING DEVICES.
Welin Marine Equipment Co., Long Island City, N. Y.

LINOLEUM CEMENT.
Ferdinand, L. W., & Co., Boston, Mass.

LIQUID GLUE, WATERPROOF.
Ferdinand, L. W., & Co., Boston, Mass.

LOCOMOTIVE CRANES—See CRANES.

LOG REGISTERS.
Nicholson Ship Log Co., Cleveland, Ohio.
Welin Marine Equipment Co., Long Island City, N. Y.

LUBRICANTS.
Albany Lubricating Co., New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.

LUBRICATING COMPOUND.
Albany Lubricating Co., New York.
Cook's Sons, Adam, New York.

LUBRICATORS.
Albany Lubricating Co., New York.
Griscom-Russell Co., New York.
Graphite Lubricating Co., Bound Brook, N. J.
Lunkenheimer Co., Cincinnati, Ohio.
Powell, Wm., Co., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.
Williams Valve Co., D. T., Cincinnati, Ohio.

LUMBER—FIREPROOF.
Johns-Manville Co., H. W., New York.
Keyes Products Co., New York.

MACHINE SHOP.
Gisholt Machine Co., Madison, Wis., and Warren, Pa.

MACHINE TOOLS—See TOOLS, MACHINE.

MAHOGANY—See LUMBER.

MANGANESE BRONZE CASTINGS—Also see BRONZE.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.

MAGNESIA COVERINGS.
Johns-Manville, H. W., Co., New York.

MANILA AND SISAL ROPE—See ROPE; also CORDAGE.

MARINE BOILER COMPOUNDS—See BOILER COMPOUNDS.

MARINE CABLEWAYS
Lidgerwood Mfg. Co., New York.

MARINE ELECTRICIANS—See ELECTRIC PLANTS.

MARINE ENGINES—See ENGINES, PROPELLING.

MARINE FORGINGS—See FORGINGS.

MARINE GAS PRODUCERS.
Galusha & Co., A. L., Boston, Mass.
Griscom-Russell Co., New York.

MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

MARINE HARDWARE.
Griscom-Russell Co., New York
Ferdinand, L. W., & Co., Boston, Mass.

MARINE LAMPS—See LAMPS.

MARINE RAILWAY BUILDERS—See RAILWAY DRY DOCKS.
Crandall Engineering Co., The, East Boston, Mass.

MARINE RANGES—See RANGES.

MARINE REFRIGERATION—See REFRIGERATING PLANTS.

MARINE SIGNALS—See SIGNALS.

MARINE SUPERHEATERS.
Babcock & Wilcox Co., New York.
Locomotive Superheater Co., New York.

MARINE SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.

MASTS, STEEL.
Welin Marine Equipment Co., Long Island City, N. Y.

MECHANICAL DRAFT.
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

MEGAPHONES—See CHANDLERY STORES.

METAL WORKING TOOLS—See TOOLS, MACHINE.

METALLIC PACKING—Also see PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
United States Metallic Packing Co., Philadelphia, Pa.

METRES, ELECTRIC.
General Electric Co., Schenectady, N. Y.
Weston Electrical Instrument Co., Waverly Park, Newark, N. J.

MILLING MACHINES.
Niles-Bement-Pond Co., New York.

MINERAL WOOL—See NON-CONDUCTING COVERING.

MONITOR NOZZLES—See HOSE NOZZLES.

MOORING ENGINES.
American Engineering Co., Philadelphia, Pa.
Hyde Windlass Co., Bath, Maine.

MOTOR BOATS—See LAUNCHES AND YACHTS.

MOTOR BOAT SUPPLIES.
Ferdinand, L. W., & Co., Boston, Mass.
Johns-Manville Co., H. W., New York.

MOTORS, ELECTRIC.
General Electric Co., Schenectady, N. Y.

MOTORS, GASOLINE—See GASOLINE ENGINES.

MULTIPLE DRILLS.
Niles-Bement-Pond Co., New York.

NAVAL ARCHITECTS—See PROFESSIONAL CARDS.

NEEDLE VALVES—See VALVES.

NIPPLES.
National Tube Co., Pittsburg, Pa.

NON-CONDUCTING COVERING.
Johns-Manville, H. W., Co., New York.

NOZZLES—See HOSE NOZZLES.

NUTS—See BOLTS AND NUTS.

OAKUM.
Baltimore Oakum Co., Baltimore, Md.
Davey, W. O., & Sons, Jersey City, N. J.
Welin Marine Equipment Co., Long Island City, N. Y.

OIL—See LUBRICANTS.

OIL BURNERS, FUEL—See FUEL OIL BURNERS.

OIL CUPS—See LUBRICATORS.

OIL ENGINES—See ENGINES, OIL.

OIL FUEL APPARATUS.
Schutte & Körting Co., Philadelphia, Pa.

OIL GAUGES.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., The, Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OIL PUMPS.
Lunkenheimer Co., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

OILING SYSTEMS—Also see LUBRICATORS.
Albany Lubricating Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Schutte & Körting Co., Philadelphia, Pa.

ORANGE PEEL BUCKETS—See DREDGING MACHINERY.

ORE DOCKS—See DOCKS.

ORE HANDLING MACHINERY.
Brown Hoisting Machinery Co., Cleveland, Ohio.
McMyler-Interstate Co., The, Cleveland, Ohio.

PACKING—Also see METALLIC PACKING.
Greene, Tweed & Co., New York.
Holmes Metallic Packing Co., Wilkesbarre, Pa.
Johns-Manville, H. W., Co., New York.
Lockwood Mfg. Co., East Boston, Mass.
Peerless Rubber Mfg. Co., New York.

PACKING, ASBESTOS.
Johns-Manville, H. W., Co., New York.

PAINT—Also see GRAPHITE; also MARINE PAINT.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Johns-Manville Co., H. W., New York.

PATENT ATTORNEYS—See ATTORNEYS, PATENT.

PETROL ENGINES—See GASOLINE ENGINES.

PHOSPHOR BRONZE CASTINGS.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Lunkenheimer Co., Cincinnati, Ohio.

PILE DRIVERS.
McMyler-Interstate Co., The, Cleveland, Ohio.

PIPE COVERING—See NON-CONDUCTING COVERING.

PIPE CUTTING AND THREADING MACHINES.
Niles-Bement-Pond Co., New York.

PIPE FLANGES—See FLANGES.

PIPE UNIONS.
Dart, E. M., Mfg. Co., Providence, R. I.
Lunkenheimer Co., Cincinnati, Ohio.
National Tube Co., Pittsburg, Pa.
Powell Co., The, Wm., Cincinnati, Ohio.
Williams Valve Co., D. T., Cincinnati, Ohio.

PIPE WRENCHES.
Williams & Co., J. H., Brooklyn, N. Y.

PLANERS, STANDARD METAL WORKING AND ROTARY.
Niles-Bement-Pond Co., New York.

PLANERS, SHIP PLATE.
Niles-Bement-Pond Co., New York.

PLANIMETERS.
Star Brass Mfg. Co., Boston, Mass.

PLATE-BENDING ROLLS.
Niles-Bement-Pond Co., New York.

PLUMBAGO—Also see GRAPHITE.
Dixon, Jos., Crucible Co., Jersey City, N. J.

PLUMBING—Also see CHANDLERY STORES.
Davidson, M. T., Co., New York.
Sands, Alfred B., & Son Co., New York.

PNEUMATIC SEPARATORS.
Griscom-Russell Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

PNEUMATIC TOOLS—Also see AIR COMPRESSORS.
Independent Pneumatic Tool Co., Chicago and New York.

POPPET VALVES—See VALVES.

PORTABLE CYLINDER BORING BARS—See CYLINDER BORING BARS.

PORTABLE DRILLS.
General Electric Co., Schenectady, N. Y.

POWER PUNCHES AND SHEARS—See TOOLS, MACHINE.

PRESSURE REGULATORS.
Ashton Valve Co., Boston, Mass.
Lunkenheimer Co., Cincinnati, Ohio.
Powell Co., Wm., Cincinnati, Ohio.
Star Brass Mfg. Co., Boston, Mass.

PRODUCERS—See MARINE GAS PRODUCERS.

PROFESSIONAL CARDS.
Cox & Stevens, New York.
Decker, Delbert H., Millerton, N. Y.
Donnelly, W. T., New York.
Hough, Edward S., San Francisco, Cal.
Watts, J. Murray, Philadelphia, Pa.

PROJECTORS—See SEARCHLIGHTS.

PROPELLER WHEELS.
Donnelly, W. T., New York.
Hyde Windlass Co., Bath, Me.
Sheriffs Mfg. Co., Milwaukee, Wis.
Trout, H. G., Co., Buffalo, N. Y.
Watts, J. Murray, Philadelphia, Pa.

PROPELLING ENGINES—See ENGINES, PROPELLING.

PUMPING MACHINERY—SEE ENGINES, PUMPING.

PUMPS—ALSO SEE ENGINES, PUMPING.
Alberger Pump and Condenser Co., New York.
Davidson, M. T., Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
Griscom-Russell Co., New York.
Hyde Windlass Co., Bath, Maine.
Kingsford Foundry & Machine Works, Oswego, N. Y.
Sands, A. B., & Son Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Machine Co., East Pittsburgh, Pa.

PUMPS, BILGE—See BILGE PUMPS.

PUMPS, DREDGING.
Terry Steam Turbine Co., Hartford, Conn.

PUMPS, MARINE GLUE.
Ferdinand, L. W., & Co., Boston, Mass.

PUNCHING MACHINES AND SHEARING MACHINES, HYDRAULI POWER AND HAND.
Niles-Bement-Pond Co., New York.

PYROMETERS.
Taylor Instrument Companies, Rochester, N. Y.

QUADRANT DAVITS—See DAVITS.

RAFTS—See LIFE BOATS AND RAFTS.

RAILWAY DRY DOCKS.
Crandall Engineering Co., East Boston, Mass.

RANGE FINDERS.
Nicholson Ship Log Co., Cleveland, Ohio.

RANGES.
Sands, A. B., & Son Co., New York.

RASPS.
Nicholson File Co., Providence, R. I.

REAMERS.
Morse Twist Drill & Machine Co., New Bedford, Mass.

REAMERS—PNEUMATIC.
Independent Pneumatic Tool Co., Chicago and New York.

RECORDING COMPASSES.
Nicholson Ship Log Co., Cleveland, Ohio.

REDUCING VALVES—See VALVES.

REFLEX WATER GAUGES.
Jerguson Gage & Valve Co., Boston, Mass.

REFRIGERATING ENGINEERS—See ENGINEERS, CONSULTING

REFRIGERATING MACHINERY.
Brunswick Refrigerating Co., New Brunswick, N. J.
Johns-Manville Co., H. W., New York.
Kroeschell Bros. Ice Machine Co., Chicago, Ill.
Roelker, H. B., New York.

REGRINDING VALVES—See VALVES.

RELEASING GEAR.
Welin Marine Equipment Co., Long Island City, N. Y.

RELIEF VALVES—See VALVES.

RESEATING MACHINES—See VALVE RESEATING MACHINES.

REVOLUTION COUNTERS.
Ashton Valve Co., Boston, Mass.
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